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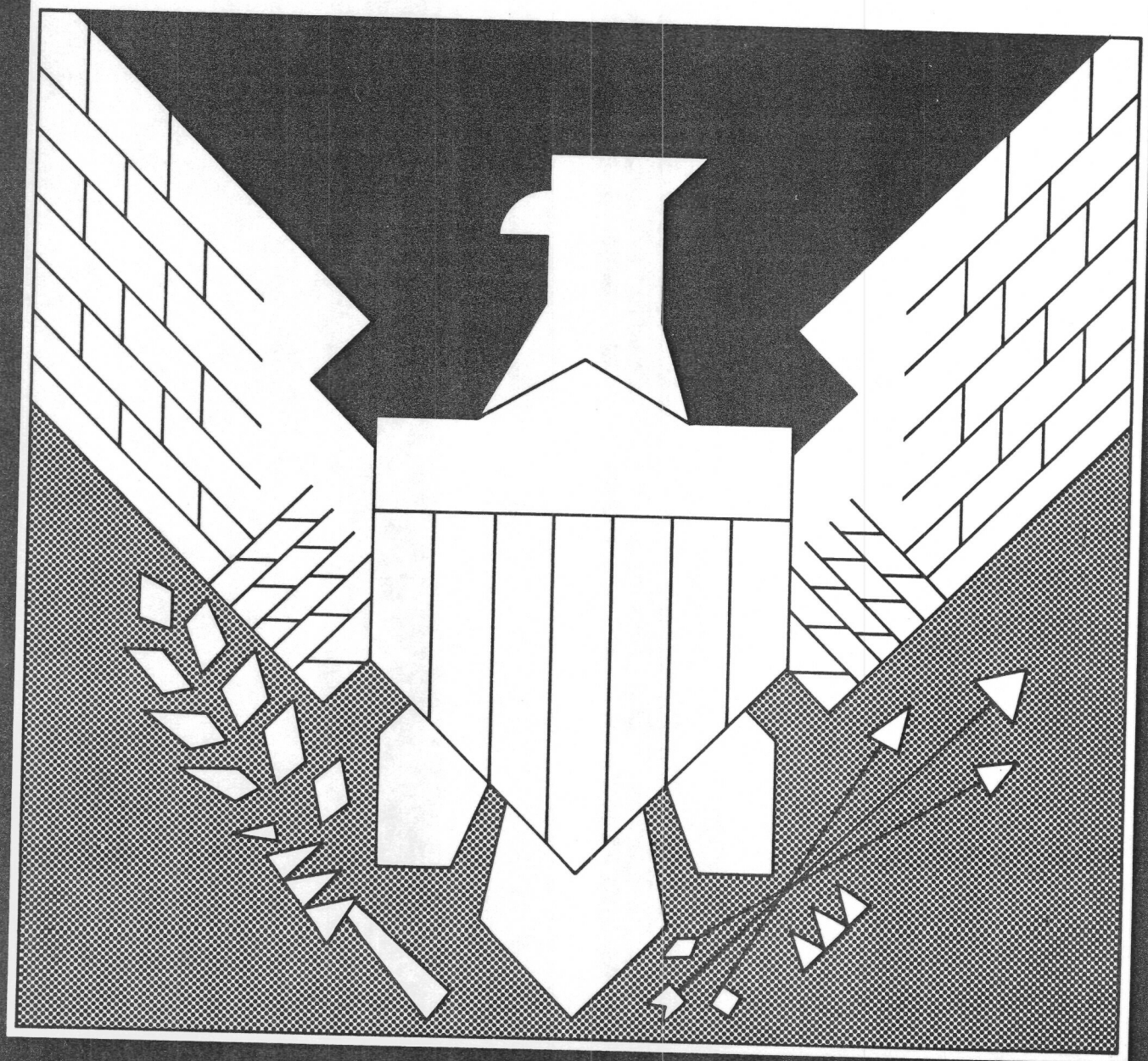
JULY 1988

Operation and Support Costs for the Department of Defense



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OPERATION AND SUPPORT COSTS FOR THE DEPARTMENT OF DEFENSE

The Congress of the United States
Congressional Budget Office

NOTES

Unless otherwise stated, all years referred to in this study are fiscal years.

Details in the text, tables, and figures may not add to totals because of rounding.

All costs are expressed in constant dollars of budget authority, using the Administration's fiscal year 1988 economic assumptions, unless otherwise noted.

Growth in funding described in the study is real growth, adjusted for inflation, unless otherwise noted.

PREFACE

Roughly half of the budget for the Department of Defense pays for annual operation and support (O&S) costs including payments for salaries, fuel, maintenance, and many other types of recurring expenses. O&S spending is often associated with the maintenance of military readiness. Readiness is defined as the ability of U.S. armed forces to fight well early in a war, a capability that could be critical to success in a major conflict.

Each year, the Congress must decide how much funding to allocate for O&S activities. Some Members of Congress have expressed concern that, with defense spending limited because of high deficits and other problems, future O&S funding might not be adequate since these funds must compete with investment funds that pay for high-priority military weapons. This analysis by the Congressional Budget Office (CBO) uses several methods to estimate how much O&S funding could be required to pay for weapons that have already been bought or will be purchased under current investment plans. The study also explores how indicators of military readiness compare with previous funding for O&S activities and how the Congress might hold down O&S costs. The study was requested by the House Budget Committee. In keeping with CBO's mandate to provide objective analysis, the study contains no recommendations.

Lane Pierrot of CBO's National Security Division prepared the study under the general supervision of Robert F. Hale and Neil M. Singer; preliminary estimates during earlier stages of the analysis were provided by Robert Kornfeld and Robert E. Mechanic. Michael Miller, of CBO's Budget Analysis Division, prepared descriptions of one of the models discussed in the study and Eugene Bryton, also of that division, provided several extensive cost estimates. The author gratefully acknowledges the contributions of Michael Berger, Bonita Dombey, William Kostak, Frances Lussier, David Moore, Jack Rodgers, Stephan Thurman, and R. William Thomas, all of CBO. Amanda Balestrieri edited the manuscript. Rebecca J. Kees, Nancy H. Brooks, and Kathryn Quattrone prepared the report for publication.

James L. Blum
Acting Director

July 1988

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SUMMARY

Operation and support (O&S) funds--the portion of the Department of Defense (DoD) budget that pays to operate DoD's forces--have grown an average of about 2 percent per year from 1980 to 1988 in real (inflation-adjusted) terms. Real growth in these accounts was higher from 1980 to 1985, averaging 4 percent per year, but has fluctuated since then; funding actually declined in real terms in 1986 and 1988. In the next several years, if overall defense budgets are held constant or decline, there may be pressure to halt growth in funding for O&S activities and perhaps to repeat recent real reductions. This pressure may become particularly severe as DoD attempts to finance the many weapons programs that have entered development or procurement during the last eight years.

These trends raise concerns. As DoD fields new systems that are both more capable and more expensive, the costs of operating and supporting these systems may rise. If funding for O&S costs does not keep pace, there may be adverse effects on military readiness--defined as the ability of U.S. forces to fight well early in a war.

This study uses several approaches to estimate the amount of O&S funding that would be needed over the next five years if DoD carries out its current investment plans. The estimates suggest that O&S funds might at least have to remain constant in real terms and may have to increase. Because deficit concerns may force reductions in defense funding, possibly including O&S funding, this study also briefly discusses several broad strategies for holding down O&S costs.

OPERATION AND SUPPORT COSTS

The bulk of funding for O&S is contained in two sets of budget accounts--military personnel and operation and maintenance. Together, these accounts make up 55 percent of the 1988 defense budget. The military personnel accounts finance pay and allowances, benefits, and bonuses for active duty and reserve military personnel. The operation

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and maintenance accounts pay for most of the rest of DoD's day-to-day operating costs, reflecting a diverse mix of activities ranging from purchases of fuel to payments for the provision of medical care. This study also includes as part of O&S funding the operating portion of the family housing accounts.

The O&S accounts are frequently referred to as the military readiness accounts. Being ready to fight well early in a war requires forces that are well manned and trained--activities that are financed with O&S dollars. Direct links between indicators of military readiness and O&S funding do not exist, however. Readiness is hard to measure because it depends on many factors including the quality and quantity of personnel, equipment, and training. Nor is it easy to relate dollars spent on O&S to changes in measures of readiness.

ESTIMATES OF O&S COSTS

What will be the requirements for O&S funds if DoD carries out its current investment plans? Because no direct links exist between O&S funds and readiness, estimates of needed O&S funding are based on past patterns of spending. There are many techniques to estimate O&S funds required by individual services, but few apply to total DoD funding. The findings presented in this study are based on two models that deal with total O&S funding as well as on the Administration's latest budget proposal.

The Defense Resources Model

The Defense Resources Model (DRM) was developed in the late 1970s for the Congressional Budget Office (CBO) and bases its projections on current (or recent) O&S funding. It projects alterations in O&S funds if the number of major forces changes: Army divisions, Navy and Air Force combat aircraft wings, and Navy ships. About 35 percent of total O&S costs are estimated directly by the DRM based on the number of major forces. A further 25 percent of total O&S costs are related indirectly to the number of forces, using various estimating relationships. The remaining 40 percent of O&S costs are assumed not to vary with changes in the number of forces.

Given current Administration plans for forces, the DRM projects that a constant level of real O&S funding over the next five years would meet requirements. Growth in the O&S costs associated with those major forces that are increasing (for example, Navy ships) is offset by savings associated with major forces that are decreasing (for example, Air Force air wings), resulting in projections of virtually zero real growth.

Because it relates O&S costs to an important determinant of military capability--the number of major forces--the DRM provides a useful estimate of O&S costs. But some expensive new weapons that do not actually increase the number of forces may nonetheless have increased operating costs. Thus, an additional approach to estimating O&S costs was used in this study.

The Capital Stock Model

The Capital Stock Model (CSM), recently developed by CBO, assumes that O&S costs are related to the dollar value of the stock of equipment operated. Some O&S costs (those for spare parts, for example) might intuitively be expected to vary with the value of a weapon; others (such as costs for medical care or administration) might plausibly be stable despite changes in weapon values. Nonetheless, empirical evidence suggests that a relationship exists between total O&S costs and the value of the capital stock.

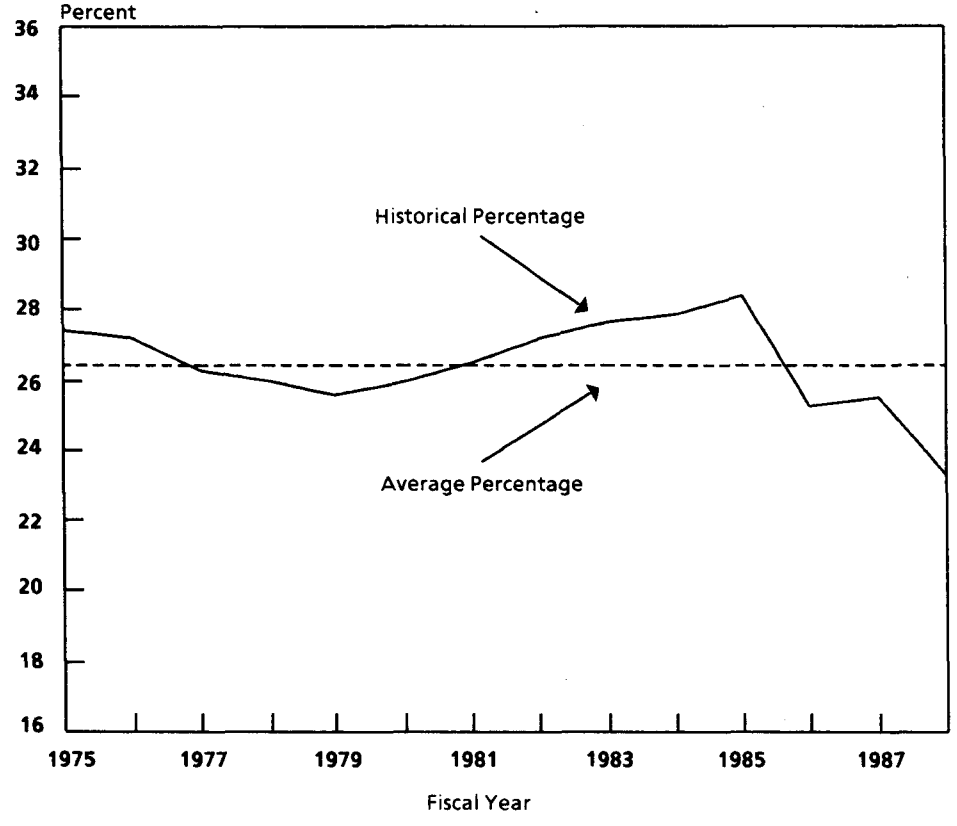
CBO's analysis calculated the ratio of real O&S costs to the constant dollar value of DoD's inventory of major weapons (such as planes, tanks, and ships). The analysis concluded that, between 1975 and 1988, the ratio (expressed as a percentage) varied within a relatively narrow band--from a high of 28 percent in 1985 to a low of 23 percent in 1988 (see Summary Figure 1). The ratio was reasonably constant over the period despite substantial changes in the total value of major weapons.

If these historical patterns persist, O&S funding would have to grow over the next five years to meet requirements. Under current plans, the value of DoD's major weapons will increase about 3 percent per year in real terms over the next five years. The increase reflects the entry of new, expensive weapons into the DoD inventory and the

retirement of older, less expensive versions. The associated growth in O&S costs depends on assumptions about the precise relationship between stocks of weapons and O&S costs. But real growth would be at least 2.3 percent per year.

The implications of the capital stock approach differ substantially from those of the DRM. For example, the CSM would require that a total of at least $35 billion (in constant 1988 dollars) more be devoted to O&S funds over the next five years than would the DRM.

Summary Figure 1.
O&S Costs as a Percentage of Capital Value



SOURCE: Congressional Budget Office from Department of Defense historical data.

The capital stock model reflects changes in DoD's inventory of weapons that may be missed by models that estimate O&S costs based only on the number of major forces. It is also based on a relationship that has been reasonably stable for many years. On the other hand, the capital stock approach assumes that all costs vary with changes in the value of weapons, even though some might be expected to be fixed or vary with factors other than capital stock. Thus, this study uses the capital stock approach along with the DRM and Administration estimates to identify a range of possible increases in O&S costs.

Administration Budget Proposal

In its latest budget, the Administration recommended increases in O&S costs averaging about 1 percent per year--roughly midway between the estimates derived using the DRM and the CSM. The Administration proposed larger increases in the operation and maintenance portion of O&S (about 2 percent per year) and almost no increase in funding for military personnel. Administration budget proposals for O&S funds are based on estimates that are reviewed and modified during DoD's complex budget review process. Thus, these estimates reflect budget limitations and many other factors in addition to judgments about needs for O&S funds.

CONCLUSIONS ABOUT FUTURE O&S COSTS

As the discussion above suggests, each of the approaches used to estimate O&S costs provides useful information but also has limitations in its methodology. Nor are such limitations the only source of uncertainty. All the techniques base their estimates on current Administration plans for the number and type of weapons. Those current plans reflect changes in the number of forces recently proposed by the Administration (including elimination of almost three Air Force air wings, 16 Navy ships, and selected Army units). But the approaches cannot anticipate further changes that may be proposed by DoD next year in response to the lower growth expected in future DoD budget requests. Nor can projections reflect changes that the Congress might make in DoD requests.

Given these limitations and uncertainties, conclusions should be drawn with caution. Perhaps the most that should be concluded is that, given historical patterns of funding and what is currently known about future plans, it will be difficult to reduce real O&S funding substantially below current levels. Indeed, there may be pressure for real increases of a few percent per year.

HOLDING DOWN O&S COSTS

Faced with concerns about the federal deficit that could result in reduced defense budgets, along with pressure for constant or even increasing O&S budgets, the Administration and the Congress may wish to consider ways to hold down O&S costs. This study examines three broad strategies as examples of possible approaches.

Reducing the Number of Forces

As DoD modifies its budget to conform with likely fiscal realities, some further reduction in the number of forces could occur. These reductions would adversely affect U.S. military capability in ways that are not analyzed here. But the reduction would also reduce O&S requirements according to the DRM; since its estimates are based on the number of forces, that model would project that O&S funds could be reduced in real terms.

It would be more difficult, however, to make changes that cause declining O&S requirements according to the CSM. Analysis in this study shows that--because capital stocks have been built up over many years--only far-reaching changes in planned procurements, or in retirements of older forces, would cause a reduction in the DoD capital stock and hence declining O&S requirements using the capital stock approach. Thus, holding down O&S costs through reductions in the number of forces would be difficult to the extent that capital stock determines needs for O&S funds.

Achieving Efficiencies

DoD could hold down O&S costs if it could deliver O&S support more efficiently. Neither of the models used in this study explicitly accounts for changes in efficiency, nor does this study attempt to identify specific efficiencies. Greater efficiency in O&S funding is attractive because it avoids the dilemma of choosing between higher costs and the risk of harming military readiness. But efficiencies are also contentious. In the past, some Members of Congress have claimed that substantial O&S funding reductions could be achieved through efficiencies while others have argued that substantial cuts risk harming military readiness.

Accepting Readiness Risks

Finally, the Congress or the Administration could simply reduce O&S funding without achieving clearly identified efficiencies or cutting the number of forces to be supported. Such changes would risk degrading the readiness of military forces. O&S funds are certainly related to military readiness; they pay for training and other activities that obviously affect the military's capability to fight well early in a war. But analysts have been unable to establish quantitative links between funding for O&S activities and measures of military readiness. Thus, analysis cannot confidently quantify the amount of risk associated with reductions in O&S funding.

CHAPTER I

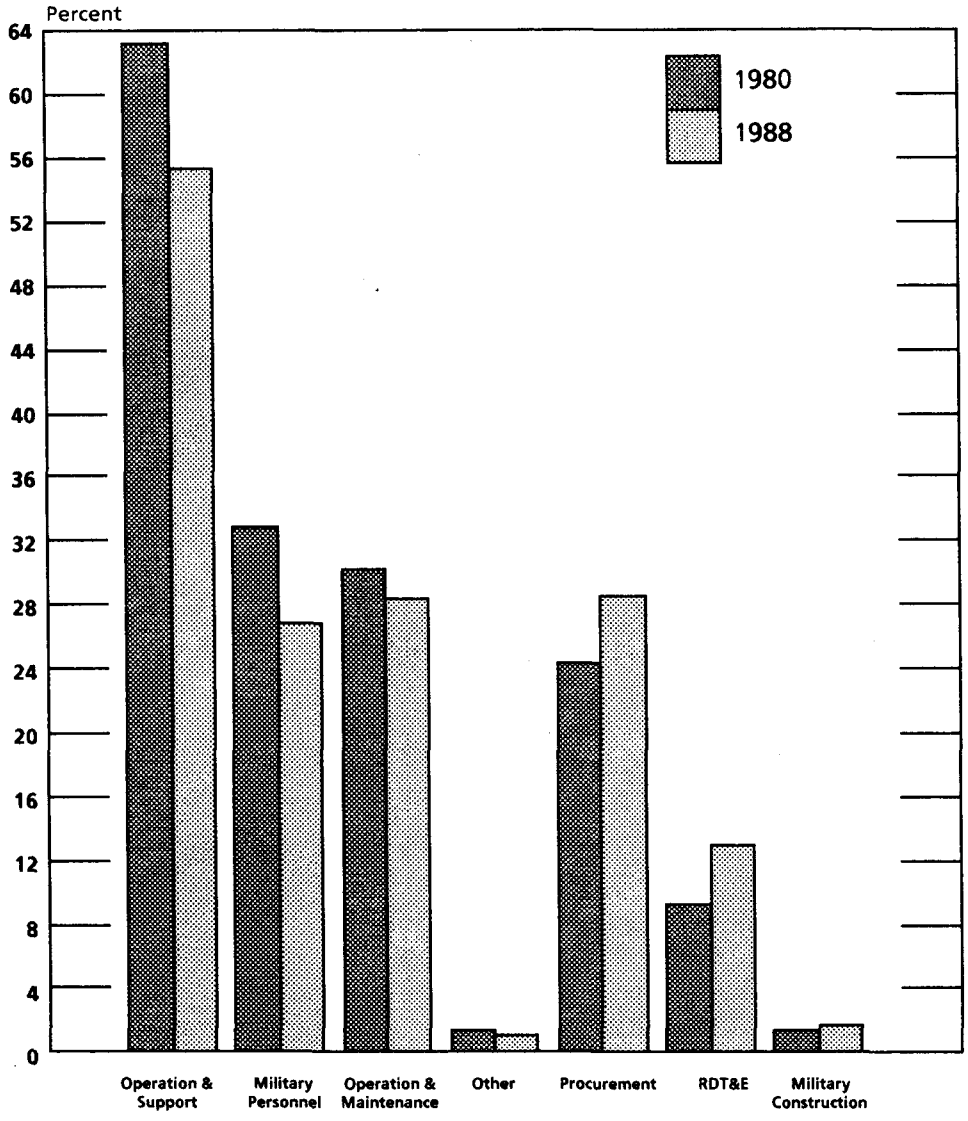
INTRODUCTION

Over the last eight years, the Administration has spent about $960 billion for the development and procurement of new weapons systems. The funds in these "investment" accounts have grown from about $69 billion in 1980 to about $118 billion in 1988, an average real rate of growth of about 7 percent per year. During this time, the portion of the budget that goes toward operating, manning, and supporting these systems--sometimes referred to as operating funds or the cost of operation and support (O&S)--has also grown, though more slowly. Total Department of Defense (DoD) spending for the two major O&S accounts--military personnel and operation and maintenance--has risen from about $130 billion in 1980 to about $155 billion in 1988, an average real rate of growth equal to about 2 percent per year. This slower growth has reduced the share of the defense budget devoted to O&S from 63 percent in 1980 to about 55 percent in 1988. (See Figure 1 for funding shares.)

These trends raise concerns. Operating funds need not necessarily grow proportionally with investment. But the large growth in investment means that new weapons are entering the military forces, which could drive up needs for O&S funds in the next few years. Large growth in investment also suggests that the military services have committed themselves to extensive programs of modernization that will expand and alter their stocks of equipment in the future; O&S needs may therefore continue to increase. Pressures for increased O&S funds could be held down or avoided altogether if new weapons have been successfully designed to minimize operating costs or if the military becomes more efficient in its delivery of operating services. If needs for O&S funds rise, however, the increase would come at a time when the total DoD budget may be restricted in its growth, suggesting that O&S needs may not be met.

Unplanned increases in O&S funding could exert pressure for decreases in investment funding. An analysis of the dynamics of bud-

Figure 1.
Department of Defense Budget Shares by Account



SOURCE: Congressional Budget Office from Department of Defense budget estimates.

NOTE: RDT&E = research, development, test, and evaluation.

get increases and cuts on operating and investment funds--presented in a 1987 article--suggests that in a constrained budget environment, increases in O&S funds can be linked to sizable decreases in investment funding.[1] The analysis presents data collected by comparing actual funding for the operating and investment portions of the budget with the previous years' plans. In times of austere budgets, a consistent underestimation of O&S costs by about 2 percent for the period from 1974 to 1980 contributed to unplanned declines in investment funding of about 14 percent in comparison with the previous year's expectations. In years of more generous budgets, O&S expenditures were also underestimated, but by less than the underestimation of the total budget. Hence, the additional money that was available in the overall budget could be spent on investment, which received its share plus some of that associated with O&S. The article argues that this is an unsurprising outcome; operating costs are relatively uncontrollable in the short term because existing forces demand a certain level of support.

Decreases in O&S funding could also be serious because they are associated with military readiness, which is defined as the ability of U.S. forces to fight well early in a war. Readiness is considered crucial by many military analysts, since it determines how well active forces could respond to surprise attacks, and how rapidly reserve forces would be available to augment them. It is enhanced if forces are fully equipped, manned, and trained in peacetime, and O&S spending influences manning and training. Direct relationships between O&S spending and readiness have not, however, been fully identified. Thus, it is difficult to predict the effects that shortfalls in O&S funds will have on readiness.

The desirable level of O&S spending, and the implications of that spending for military readiness, have been contentious topics for years. That debate is likely to continue, especially as the high investment spending of the early 1980s alters DoD's stock of weapons at the same time that concerns about the deficit hold down increases in total DoD spending. At issue is the question of how much of DoD's total budget must be devoted to O&S funding if the defense department continues its current plans for investment in weapons. This study

1. Rolf Clark, "Defense Budget Instability and Weapon System Acquisition," *Public Budgeting and Finance*, vol. 7 (Summer 1987), pp. 24-36.

breaks no new ground in defining requirements for O&S funds, or in linking support funding to readiness. Instead, the study develops an analytical basis for projecting future levels of O&S spending based on historical patterns and uses these tools to estimate future needs. The study also discusses choices the Congress could make to hold down O&S costs.

DEFINITION OF O&S COSTS

As defined in this study, O&S costs are the total of the operation and maintenance accounts, the military personnel accounts, and the portion of the family housing accounts aimed at short-term maintenance of DoD family housing.

Operation and Maintenance

Operation and maintenance funding, totaling about 28 percent of the 1987 DoD budget, pays for diverse activities (see Table 1). These activities are loosely connected in that they all pay for relatively short-term operating expenses for DoD.

Much operation and maintenance funding pays to run and repair DoD's stock of equipment. For example, it pays for the fuel to run DoD's equipment and buys spare parts and supplies for that equipment.[2] It also pays for equipment maintenance contracts for various weapons systems.

In addition, the operation and maintenance accounts pay for items less directly related to equipment. For example, salaries for more than 90 percent of all DoD civilians are funded by this appropriation. While some of these civilians are engaged in equipment maintenance activities, many are not: they may be medical personnel, clerical staff,

2. Operation and maintenance pays for those spares that are not themselves repairable for the Army and the Air Force. Repairable spares for these two services are funded by the various procurement accounts. The Navy has been trying a somewhat different system for its spares funding. All Navy spares that are not directly related to filling an initial inventory for a military base or a ship are bought by the operation and maintenance account.

TABLE 1. OPERATION AND MAINTENANCE FUNDING BY MAJOR ACTIVITY (In fiscal years, in billions of dollars of 1988 total obligational authority)

Activity	1980	1981	1982	1983	1984	1985	1986	Annual Real Growth (Percents) 1980-1985	Annual Real Growth (Percents) 1985-1986
Flying Hours	6.5	7.2	7.5	7.1	5.8	6.4	6.9	0	8
Ship Operations	2.1	2.8	3.1	3.1	2.9	2.8	2.5	5	-10
Base O&S	9.9	9.7	9.7	10.1	10.8	11.0	11.1	2	1
Real Property Maintenance	3.1	3.9	4.6	4.6	4.8	5.4	5.4	12	0
Strategic Forces	n.a.	3.2	1.9	4.0	4.1	4.3	3.8	n.a.	-11
Land Forces	2.4	2.2	2.7	3.3	3.6	3.9	4.0	10	2
Command, Control, and Communications	1.7	2.0	2.3	2.8	2.7	3.0	3.1	12	5
Airlift & Sealift	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.5	n.a.	n.a.
Reserve Activities	4.8	5.1	5.4	5.8	5.7	6.2	6.3	6	1
Depot Maintenance	8.3	9.3	9.9	11.4	11.6	12.4	10.3	8	-17
Modernization	1.6	1.9	1.9	2.0	2.1	2.3	2.2	8	-6
Supply	3.0	3.1	3.2	3.5	3.7	4.1	4.0	6	-2
Transportation	2.5	2.6	2.8	2.5	2.5	2.2	2.1	-2	-5
Other Logistics	4.2	4.9	5.5	5.5	5.7	6.7	6.5	10	-2
Training/Education	1.8	2.0	2.3	2.5	2.6	2.8	2.8	9	0
Recruiting/Advertising/ Examinations	0.5	0.5	0.5	0.5	0.6	0.6	0.6	5	2
Medical	2.9	3.1	3.4	3.8	4.0	4.1	4.7	8	14
Other	13.0	7.7	4.7	5.3	6.1	10.9	11.4	-3	5
Administration	1.9	2.0	2.3	2.4	2.9	2.8	2.8	9	-2
Adjustment for Overlap and Revolving Funds[a]	-7.2	-5.6	-2.1	-4.2	-3.4	-9.2	-9.2	n.a.	n.a.
Total	62.9	67.6	71.7	75.8	78.9	84.2	82.8	6	-2

SOURCE: Congressional Budget Office estimates from Department of Defense, *Operation and Maintenance Overview*, various years, and *National Defense Budget Estimates for Fiscal Year 1988/1989*.

NOTE: n.a. = not applicable.

a. Overlap occurs primarily because reserve forces support is included in a number of major activities. Revolving fund adjustment mainly reflects stock and industrial fund rebates.

civilians who train military personnel, or dozens of other types of support employees. Operation and maintenance also covers funding for maintaining DoD facilities.

After rapid growth in the first part of the 1980s, operation and maintenance funding has fluctuated in recent years. From 1980 to 1985, growth averaged about 6 percent per year in real terms. In 1986, real funding declined by about 4 percent when the budget cuts made under the Balanced Budget and Emergency Deficit Control Act of 1985 (commonly called Gramm-Rudman-Hollings) came into effect. In 1987, funding increased by about the same amount, but then declined by about 5 percent in 1988.

Military Personnel

The military personnel (milpers) accounts provide pay and benefits for the roughly 2.2 million active duty personnel and 1.2 million reservists in the military services. (Reservists are military personnel who train only part time.) Military personnel funding, which is about half of what this study defines as O&S costs, totaled about $78 billion in 1987 or about 26 percent of the DoD budget. Included in these accounts are:

- Military pay and allowances;
- Travel costs associated with moving military personnel from one duty station to another (so-called permanent change of station costs);
- Bonuses for enlistment and reenlistment; and,
- Since 1985, "retired pay accrual," an estimate of the retirement benefits that will eventually be paid to current service members.[3]

Military personnel costs have grown more slowly than operation and maintenance costs, averaging real growth of about 2 percent per year from 1980 to 1985, and about 1 percent from 1980 to 1988.[4]

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3. O&S costs in earlier years have been adjusted by adding estimates from DoD for retired pay accrual in years before 1985.

4. Real growth in these accounts may have been more rapid. Pay raises are typically defined as inflation and removed when the accounts are adjusted to real dollars. Some argue that pay raises exceeded inflation in some years during this period and actually contributed to real improvements in capability, such as recruiting a more productive force.

Other Elements of O&S and Definitional Issues

Other items might be considered operating costs in the DoD budget. For example, the accounts for family housing--partially an investment expense in that it includes construction costs--also contain operating funding, amounting to about 1 percent of the DoD budget. The operating portion of family housing costs is counted in this study as part of O&S funds. Table 2 summarizes the various components of the 1987 O&S budget as it is defined in this study.

TABLE 2. OPERATION AND SUPPORT FUNDING

Included in O&S:

Operation and Maintenance (about 28 percent of fiscal year 1987 DoD budget):

- Salaries for about 90 percent of DoD civilians
- Facilities maintenance and maintenance contract services
- Fuel
- Supplies
- Repair parts
- Some personnel support

Military Personnel (about 26 percent of fiscal year 1987 DoD budget):

- Active and reserve component pay and allowances
- Permanent change of station
- Bonuses
- Retired pay accrual

Family Housing Operating Costs (about 1 percent of fiscal year 1987 DoD budget).

Stock Fund Rebate ($5.3 billion in 1987).

Arguably part of O&S but not included:

Spare parts needed for peacetime training.

SOURCE: Congressional Budget Office analysis.

NOTE: DoD = Department of Defense; O&S = operation and support.

DoD stock funds are a complicating factor in accounting for operating costs. Stock funds are revolving funds that purchase items--for example, spare parts, fuel, and clothing--and sell them to the services as "customers." The stock funds allow DoD to centralize its purchases with attendant economies of scale. Items bought from the funds are typically paid for out of operation and maintenance funds. Periodically, the stock funds overestimate costs and provide rebates to the service customers. In recent years, rebates have been sizable, partially because of the overestimation of fuel prices.[5] As these rebates may arguably have been used to fund items that would otherwise have required new operation and maintenance budget authority, this study includes their value in O&S costs.

Many spare parts are purchased out of accounts that DoD labels as investment. Nonetheless, it could be argued that these purchases are operating expenses because the items they fund replace those worn out as a result of DoD operations. Indeed, instead of relying on investment funds as it had done previously, the Navy began using O&S funding for the purchase of some repairable spare parts for ships in 1981 and for aircraft in 1985.

Inclusion of these costs, however, would result in estimates that differ from those typically considered in Congressional discussions of O&S funding. Hence, estimates in this study do not include them. Moreover, analysis suggests that their inclusion would not significantly alter the study's results.

Changes in the definition of what is included in various accounts--particularly the operation and maintenance and military personnel accounts--also complicates discussions of O&S funding. Contracting out is one such change. Though not well documented, there may have been an increase in the amount of contracting out to the private sector of maintenance activities performed in the past by military personnel. Since payments to private contractors come from the operation and

5. If the stock funds can overestimate costs, they can also underestimate them. Fuel prices are particularly volatile and have led to an underestimation in the 1988 budget that will--according to DoD--cause a shortfall of about $450 million in funding for that year. When such an underestimation occurs, the services pay for the addition out of operation and maintenance funds. DoD can ask the Congress to make up the difference, but if funds are not forthcoming the service operation and maintenance accounts must absorb the difference. Another source of volatility can come from overseas allowances that vary in response to fluctuations in currency exchange rates.

maintenance accounts, increased contracting out of services would cause a shift of funds from the military personnel accounts to the operation and maintenance accounts. An aggregate measure of O&S such as the one used in this study would capture both kinds of funding, but more detailed comparisons could be affected by such funding shifts.

A more important definitional problem is the "migration" of funds for activities previously paid for by other accounts to the O&S account. The Navy's decision to pay for spare parts from O&S rather than investment accounts is an example of migration. Another example is leasing equipment, rather than buying it using investment funds. Leasing increased in the 1980s, though it may have declined recently, and has the effect of transferring the source of funding to O&S accounts because these accounts pay for leasing costs. This study did not make adjustments for these definitional shifts.

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BASIS FOR PROJECTIONS

Results in Table 3 depend on the number of military forces and the types of weapons that will be in DoD's inventory over the next five years. In this chapter, estimates of forces are based on the latest available Administration plans. Since the Congress currently approves most DoD plans one year at a time, the analysis has no basis for incorporating future changes in those plans. If the Congress alters the plans, the projections in this analysis could prove to be either too high or too low.

Administration plans are based primarily on the detailed five-year defense plan submitted to the Congress over a year ago in January 1987. This is the most recent detailed five-year plan that is

TABLE 3. REAL GROWTH IN O&S FUNDS ASSUMING LATEST AVAILABLE ADMINISTRATION PLANS FOR FORCES AND WEAPONS

	Average Annual Real Growth, Fiscal Years 1988-1993 (Percents)
Defense Resources Model	0
Capital Stock Model	
Average ratio for 1975-1988	5.5
1988 ratio	3.0
Regression using 1975-1987 data	4.7
Regression adjusted for 1989 residual[a]	2.3
Administration's Latest Budget Proposal	1

SOURCE: Congressional Budget Office projections and amended Administration budget request for fiscal years 1988 and 1989.

a. This estimate assumes a continuation of the linear association between O&S and capital stock based on the 1975 to 1987 regression, but the intercept is adjusted downward to coincide with the Administration request for 1989.

available. The plan envisioned real growth of about 3 percent per year in total DoD funds through 1992. The bipartisan budget agreement, reached in November 1987, changed this outlook. As a result, DoD submitted a budget amendment for 1989 that requested funding substantially below its original 1989 request. In addition, DoD has indicated that it will reduce its spending requests in years beyond 1989.

Unfortunately, except for 1989, detailed plans consistent with this reduced funding have not yet been made available to the Congress. This study has incorporated proposed 1989 changes and, where possible, has modified forces beyond 1989 to reflect the changes. Thus, for example, the reductions in the number of military forces proposed by DoD (16 Navy frigates, almost three Air Force air wings, and some Army units) are reflected in the results of this analysis.

MODELS AND PROJECTIONS

The two models used in this study--the Defense Resources Model and the Capital Stock Model--take very different approaches to estimating aggregate O&S costs. Details of the models' methodologies are presented in Appendix A.[1]

The Defense Resources Model

The DRM--a model developed in the 1970s for the Congressional Budget Office--assumes that O&S costs are driven by a host of personnel, facilities, and weapons policies implicit in the current budget.[2] The intent of the model is to project costs if these policies do not change and to forecast the effects of changes in forces on costs. Accordingly, the DRM captures the effects of changes in major forces

1. The DRM is used to estimate all parts of the defense budget, but this study discusses only its estimates of O&S costs for the services. The CSM is limited to projecting O&S funding for the Army, Navy, and Air Force.

2. General Research Corporation, Management Systems Division, *Defense Resources Model, Volume 1 - Model Logic and Data Requirements* (August 1981), prepared for the Congressional Budget Office. The model has been periodically updated.

including Army divisions, Air Force and Navy combat aircraft, and Navy ship inventories.

Changes in the number of these major forces are assumed by the DRM to be related to the direct costs of O&S. An example of a major force change in the DRM might be the retirement of a conventional aircraft carrier. Direct O&S costs that would be affected by this action would include items such as fuel, spare parts, and pay for personnel who run the ship. The DRM assumes that direct O&S costs for each major force unit are constant in real terms throughout the period when a projection is made. Costs for each unit of forces are normally derived from the latest DoD budget submission for which details are available.[3] For the aircraft carrier example, the DRM would predict annual real savings in direct O&S costs of about $0.2 billion if a conventional aircraft carrier were retired. The DRM phases costs: changes are assumed to occur in the middle of the year of the change. For the first year that the carrier was retired, therefore, direct savings would total only about $0.1 billion. Roughly 35 percent of DoD's total O&S budget is predicted by the DRM using this technique for direct O&S costs.

The DRM also uses various estimating relationships to assess changes in indirect O&S costs associated with changes in major forces. Indirect O&S costs include such items as training costs, medical costs, and personnel support. In the case of the retirement of a conventional aircraft carrier, indirect O&S savings would amount to about $0.1 billion per year. About 25 percent of DoD's total O&S budget is estimated using this indirect method.

Finally, the DRM assumes that about 40 percent of O&S costs are fixed--that is, they do not vary with changes in the number of major forces. Examples of such fixed costs might include funds to support base operations or to repair real property.

DRM Results. Based on the assumptions described above about Administration plans for forces, the DRM projects that O&S costs will

3. Results for the DRM are based on funding levels presented for 1987 in the fiscal year 1988 budget submission.

TABLE 4. ASSUMED NUMBER OF SELECTED FORCES IN DEFENSE RESOURCES MODEL (In fiscal years)

	1988	1989	1990	1991	1992	1993
			Navy			
Ships	484	486	486	490	496	496
Air Wings	15	15	15	15	15	15
			Army			
Divisions	28	28	28	28	28	28
			Air Force			
Air Wings	38	36	35	35	35	35

SOURCE: Congressional Budget Office from Department of Defense data.

NOTES: The forces in this table include active and reserve forces. The model also includes estimates for other major force elements including strategic forces and airlift.

remain roughly constant over the next five years, with no significant real increases or declines through 1993.[4] Thus, while the DRM does not suggest that O&S costs could be a source of funding cuts, it does suggest that DoD will not need funding increases above those needed to pay the costs of inflation to meet its O&S requirements.

The DRM's projection reflects expected modest declines in some major DoD forces offset by modest increases in others. (See Table 4 for assumptions about selected major forces.) Over the next five years, the Navy would continue to grow toward its goal of 600 deployable ships. (Only a portion of the Navy's 600-ship battleforce influences the DRM estimates.) The Air Force, on the other hand, plans to cut almost three tactical air wings from its current level of about 38 wings. The Army would maintain the same number of divisions, although it does plan some cuts below its current level of about 780,000 military personnel and would delay or abandon plans to man all divisions at desired levels.

4. The DRM actually projects slight (less than 0.01 percent) real growth for this period.

DRM Assumptions. The DRM makes assumptions that lead to what might be termed a "constant readiness-spending" estimate. The model assumes that, if DoD could operate a particular unit of major forces with a certain number of O&S dollars during a recent year, it can do so again. This assumption results in estimates that are a useful guide to future O&S needs.

The DRM's assumption that portions of O&S funding will not increase in response to changes in the number of major forces also provides a useful guideline. Especially for elements of cost that relate to maintaining facilities and to overhead, the assumption seems plausible. For example, one might reasonably assume that the addition of a squadron of aircraft at an Air Force base that already has several squadrons in operation would not greatly increase the base's overhead costs.

On the other hand, analysis suggests that costs for base operations, real property maintenance, and management overhead have held a constant share of total operating costs, rather than a constant value, at least during the period from 1975 to 1985. The share varied by only two percentage points for the period from 1975 to 1985, when O&S costs grew from $125 billion to $160 billion. Thus, the DRM assumption does not reflect past trends in operating costs and may not capture future trends. This suggests that a range of approaches to estimating future O&S costs should be employed.

Moreover, the DRM does not capture the effects on O&S costs of changes other than those in major forces. If a service adds weapons within a major force unit but does not increase the number of those units--as the Army has done in some of its divisions--the DRM would not capture any increased O&S costs.

The Capital Stock Model

The second approach used in this study to estimate O&S costs assumes they are related to the dollar value of the stock of equipment that is being operated. For some categories of O&S costs, this relationship is intuitively plausible. Costs of spare parts, for example, are likely to increase with the value of equipment. Indeed, a number of the models developed by or for specific services and discussed in Appendix B (but

not used in this study) use capital stock as one of the determinants of O&S funding. Other O&S costs, however, might not seem to be related to capital stock. Funds for medical care or base operations fall in this category.

Notwithstanding these intuitive conclusions, empirical analysis suggests that, for the period from 1975 to 1988, total O&S funding is related to the value of the capital stock of major weapons. CBO constructed a capital stock series for that period by applying procurement values to DoD inventory data for major weapons systems (ships, combat aircraft, and large land combat vehicles). O&S costs were defined as including military personnel and operation and maintenance funding, as well as the operating costs in the family housing accounts and dollars associated with industrial and stock fund rebates. Figure 2 shows the ratios (expressed as percentages) of these O&S costs to the dollar value of all major weapons, ranging from a low of 23 percent in 1988 to a high of about 28 percent in 1985. Over the period from 1975 to 1988, the average is 26 percent. The relationship is reasonably stable despite substantial changes in the capital stock, which grew from about $450 billion in 1975 to about $650 billion in 1988.

The data in Figure 2 can also be summarized using the statistical technique of regression. During the period from 1975 to 1987, there is a statistically significant relationship between O&S funding and the real value of the capital stock of major weapons.[5] Appendix A discusses more fully the methods used to construct the capital stock series and the analysis of the data.

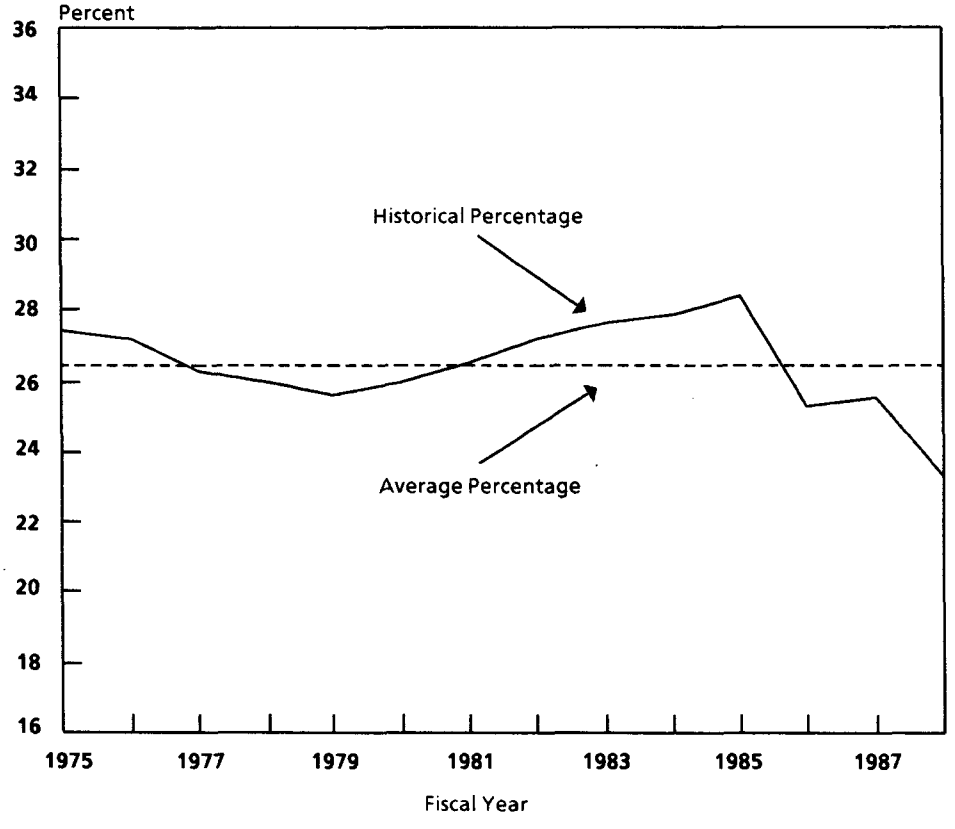
CSM Results. A different picture emerges from that provided by the DRM when the CSM is used to predict O&S costs. Although overall force levels are projected to remain relatively constant over time--with major forces increasing in some services and decreasing in others--substantial modernization of forces in all the services will continue for several years. As a result, more expensive equipment will enter the

5. The inclusion of data points for 1988 and for the 1989 proposed budget causes the statistical relationship between capital stock and O&S costs to become much less clear. Appendix A discusses the implications of this result for the analysis.

inventory, increasing the value of DoD's capital stock. Figure 3 shows that capital stock values for major weapons will rise by about 3 percent per year in real terms between 1988 and 1992 (based on assumptions about Administration plans noted above).

If the historical relationship between capital stock value and O&S costs holds in the future, increases of this size in the stock could lead to increases in O&S costs ranging from 2.3 percent to about 5.5 percent per year (see Table 3 on page 12). The range depends on which of the past relationships between O&S and capital stock is used to project future increases in funding. All the estimates are positive because the capital stock is increasing.

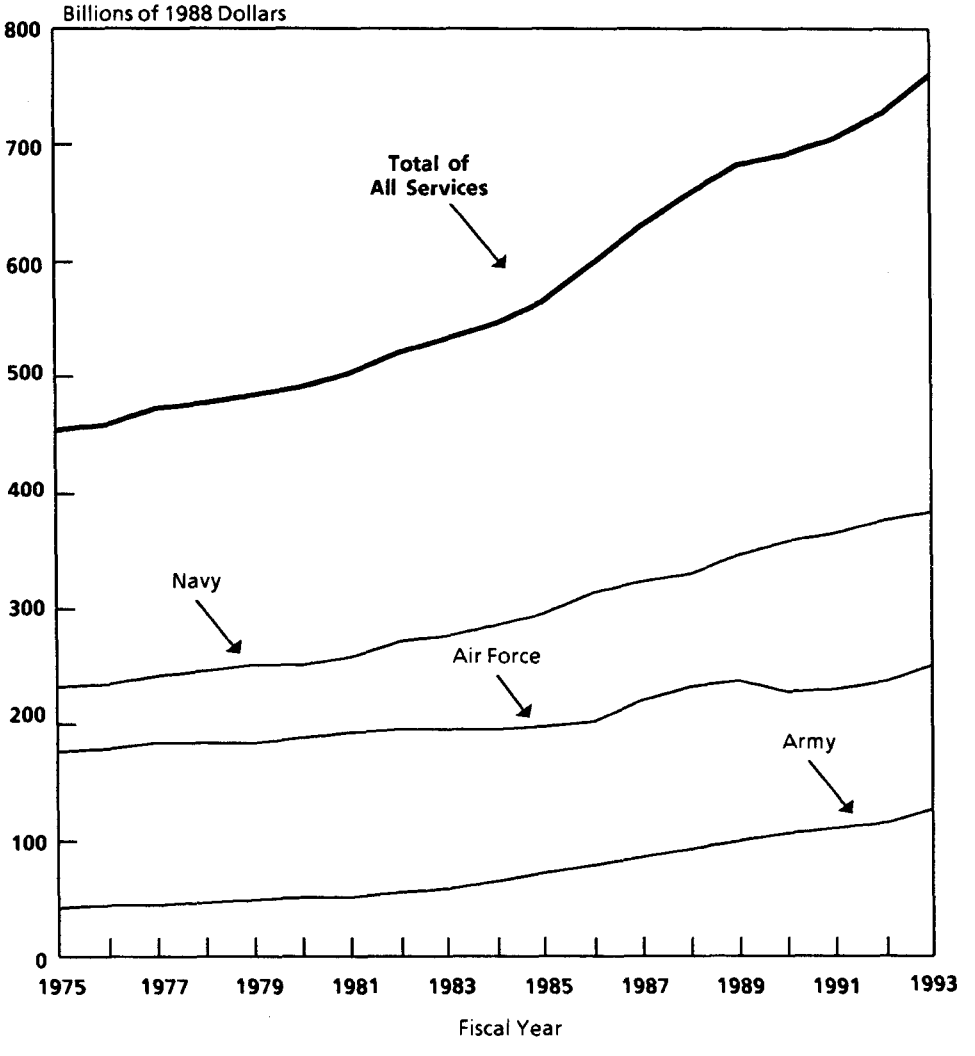
Figure 2.
O&S Costs as a Percentage of Capital Value



SOURCE: Congressional Budget Office from Department of Defense historical data.

The highest estimate of future funding increases (5.5 percent per year) assumes that, in the years beyond 1988, the ratio of O&S funds to the capital stock of major weapons returns to the average level that existed from 1975 through 1988. This requires not only increases in

Figure 3.
Values of Major Weapons



SOURCE: Congressional Budget Office estimates.

O&S funding because of increases in the capital stock, but also a "catch-up" increase because the 1988 ratio is below the historical average. The lowest estimate of future funding increases (2.3 percent per year) uses the regression relationship for 1975 to 1987 to project future increases but adjusts the projections by the difference between estimated and proposed 1989 funding. Thus, there is no catch-up increase. Other assumptions lead to intermediate results (see Table 3). The lowest, and thus most conservative, estimate is used when discussing CSM results in the remainder of this study.

CSM Assumptions. The CSM may capture important trends that are not represented in approaches focusing on the number of forces. For example, in recent years there has been a trend toward the purchase of more expensive weapons.[6] Those expensive weapons could be more costly to repair and perhaps to operate, but because they are being bought in small numbers, they may not add to the number of forces.

Moreover, the CSM approach captures an empirical relationship that has existed for the past 14 years. During this period, the capital stock of major weapons has changed substantially. The existence of the relationship during a lengthy period, coupled with the knowledge that some types of O&S costs are usually assumed to be related to capital value, suggests that it is reasonable to consider the results of this model when assessing how O&S costs might change.

On the other hand, the CSM assumes that all O&S costs are variable and related to the value of DoD's stock of major equipment. This assumption implies that all categories of O&S costs will rise as the result of both modernization and increases in forces. Such a conclusion seems inappropriate: some newer weapons systems might actually be less costly to operate because they are designed to achieve savings in maintenance costs, while other categories of O&S costs could remain the same even when the value of capital stock increases. These aspects of the CSM model suggest that other approaches should also be considered in assessing how O&S costs may change.

6. See statement by Robert F. Hale, Assistant Director, National Security Division, Congressional Budget Office, given before the Subcommittee on Conventional Force and Alliance Defense and the Subcommittee on Defense Industry and Technology of the Senate Committee on Armed Services, March 17, 1987.

Administration Plans

Administration estimates for O&S requirements, submitted in February 1988, project annual real growth in O&S funding of about 1 percent through 1993. These estimates fall roughly in the middle of the range of estimates provided by the DRM and CSM models (almost 0 percent to about 2.3 percent per year). Much of the Administration's planned growth is in the operation and maintenance accounts, which increase about 2 percent per year over the next five years. Under Administration plans, spending in the military personnel accounts is projected to grow much more modestly, at about 0.2 percent per year over the next five years.

The Administration's estimates of O&S funds are based on estimates that are then reviewed and altered by many managers during DoD's complex process of budget review. Results are presented in great detail for the budget year 1989, but detailed plans are not available for the years beyond 1989.

A variety of trends characterize the Administration's proposed increase in operation and maintenance funding. All operation and maintenance programs receive 2 percent real growth in funding in 1989 over 1988, except for the reserve forces program, which shows a decline. In contrast to this real growth, however, the Administration's current operation and maintenance request falls short of its plan of a year ago in almost every program. The Air Force budget request accounts for more than half of the overall growth in funding for operation and maintenance--growing by over 5 percent in 1989, which is more than $1.2 billion in real terms. The largest real growth among the major categories (listed in Table 1, Chapter I) is found in strategic forces and airlift and sealift.[7]

The Administration's budget proposal is an important factor in the debate over O&S funding, since Congressional action uses this proposal as its starting point. But because the budget proposal is the product of a complex review, it may not represent the Administration's assessment of needs for O&S funding in isolation. Instead, aggregate budgetary limitations may impose constraints on funding that

7. For more details on changes in the 1989 budget, see Congressional Budget Office, *An Analysis of the President's Budgetary Proposals for Fiscal Year 1989* (March 1988).

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are shared by O&S and investment programs. Moreover, as a political document, the Administration's proposal incorporates its budgetary priorities, which may differ from those of the Congress.

Other Approaches

There are many other methods of estimating O&S costs in addition to those just discussed. The military services, which have long faced the problem of budgeting for O&S funds, have developed or sponsored the development of many models relating O&S funding to the size and composition of forces. These models range in complexity from simple approaches--projecting O&S as a constant share of future DoD budgets--to complex techniques, with detailed estimates for many of the large variety of systems fielded by DoD. Models also vary in terms of how recently their underlying data have been updated to reflect changing system costs.

Table 5 describes five representative models. These five models--the Air Force Cost Oriented Resource Estimating (CORE) model (a cost handbook), the Navy Resource Model (NARM), the Navy O&S Cost Model, the Navy Resource Dynamics Model, and the Army Force Planning Cost Handbook (AFPCH)--deal only with costs for a specific service. Because of their narrower scope, these models are less helpful in projecting total O&S funding levels in this study, though they are quite useful in other more detailed analyses, such as measuring the costs of individual weapons systems. Appendix B provides brief discussions of their methodologies.

COMPARING THE ESTIMATES

Although they bracket the Administration estimate, the results of the DRM and the CSM are very different. The DRM projects almost no real growth in O&S needs for the next five years, while the CSM projects increases of at least 2.3 percent per year for the same period. The dollar difference between these projections is considerable. O&S funding projected at CSM's level exceeds that of the DRM by a total of about $35 billion for the five-year period from 1989 to 1993.

When results diverge so dramatically, there may be reason to be skeptical of both models. After all, the O&S accounts are extremely diverse, and they may be amenable to efficiencies that neither of these models captures explicitly. Moreover, O&S funding could be affected by intentional or unintentional reductions in military readiness,

TABLE 5. SUMMARY OF MODELS THAT ESTIMATE O&S COSTS FOR THE INDIVIDUAL SERVICES

Model	Service	Sample Input	Output	Comments
Cost Oriented Resource Estimating (CORE) model	Air Force	System-specific historical factors for aircraft, such as use of POL, and squadron-manning packages.	Squadron-specific variable O&S costs.	Estimates only marginal costs of force changes.
Navy Resource Model (NARM)	Navy	System-specific historical factors for ships and aircraft.	Ship- and aircraft-specific direct and average indirect O&S costs.[a]	Estimates marginal costs of force changes. Not publicly available since 1982.
Army Force Planning Cost Handbook (AFPCH)	Army	Budget data and asset value.	Unit-specific variable O&S costs.	Last published in 1982.[b]
Navy Resource Dynamics Model (George Washington University)	Navy	Historical O&S data, asset values, and operating tempos.	Navy O&S costs.	Uses regression relationships where applicable, and proportional and fixed costs elsewhere.
Navy Operating and Support Cost Model (Institute for Defense Analysis)	Navy	Historical O&S details, system characteristics, asset values, and operating tempos.	Unit-specific O&S costs.	Classified model.

SOURCE: Congressional Budget Office based on documentation for the various models.

NOTE: POL = petroleum, oil, and lubricants.

a. Direct and indirect costs were reported before 1980, but only direct costs were reported in 1982.

b. The *Army Force Planning Cost Handbook* (AFPCH) was published through 1982 and then superseded by the *U.S. Army Cost Factors Handbook*, which was last published in December 1984.

which are not reflected in either model. Indeed, some Administration officials believe such reductions may have already occurred.

In addition, there is the uncertainty about the details of future plans for the number and type of weapons to be used by the services, plans that will affect O&S needs. As much as possible, this study has accounted for changes in plans proposed to date. But DoD has not completed its detailed plans beyond 1989. When it does, there could be further revisions in estimates of O&S funds. Moreover, the Congress could alter DoD's proposals as it reviews them. A sensitivity analysis discussed in Chapter III suggests that the changes, unless they are far-reaching, will not markedly alter results from the CSM. But the possibility of changes adds to the uncertainty.

Given these limitations and uncertainties, perhaps the most that should be concluded is that--given historical patterns of funding and what is currently known about future DoD plans--it may be difficult to reduce real O&S funding substantially below current levels. Indeed, there may be pressure for some real increases. These findings seem consistent with current Administration plans for O&S funding, which call for modest growth.

These conclusions suggest that, if the Administration and the Congress decide that deficit concerns require reductions below current levels in total DoD funds, most of the reductions would have to come from the investment accounts. Alternatively, the Congress could consider decisions that might limit needs for O&S funds.

CHAPTER III

LIMITING OPERATION AND SUPPORT FUNDING

Depending on what factors most influence operation and support costs, the results in the preceding chapter suggest that current Department of Defense investment policies will lead to O&S costs that remain constant in real terms or increase by a few percent per year. Faced with total DoD budgets that may remain constant or even decline, the Congress may consider options that hold down O&S costs. This study addresses the implications of selected, broad approaches to limiting O&S costs. The approaches are illustrative and do not consider all the possible changes that could be made in such a diverse budget category.

The Congress could hold down O&S costs by reducing the number of military forces. It will be difficult, however, to avoid increases in the value of the stock of weapons; hence, to the degree that O&S costs are determined by the capital stock, it will be difficult to limit their growth. The Congress could also seek to make O&S spending more efficient, though attempts to do so in recent years have sparked controversy about the nature of these efficiencies. Finally, the Congress could hold down O&S costs without changing the number of forces, thus accepting the risk that military readiness might decline. It is, however, difficult to quantify the link between O&S spending and measures typically used to assess military readiness.

REDUCING THE NUMBER OF FORCES

Regardless of which model is used, estimates of O&S costs in this study would be lower if the Administration and the Congress agreed on reductions in the number of forces or in planned procurements. Such reductions are certainly possible. Indeed, the Secretary of Defense has argued that, relative to last year's five-year defense plan, the plan now being formulated for 1989 to 1993 must be reduced by a

total of about $300 billion. Only $33 billion of those savings were achieved in the 1989 proposals. Reductions in the number of forces beyond those already planned would adversely affect military capability; this study does not address these effects.

Reductions in the number of major forces (ships, aircraft, Army divisions) would probably cause the Defense Resources Model to predict real declines in O&S funding. The reductions would be dampened by the DRM's assumption that about 40 percent of the O&S budget does not vary with changes in the number of major forces. But the cuts in O&S costs could still be substantial. For example, in its latest budget submission, the Administration proposed the elimination of about three Air Force tactical fighter wings, 16 Navy ships, one Navy air wing, and some Army forces. That cutback reduced DRM estimates of required growth in O&S funding by roughly 0.3 percentage point (several billion dollars) per year.

Using the Capital Stock Model, it would be more difficult to reduce force numbers enough to generate projections of constant or falling O&S costs. The CSM assumes that, if the dollar value of major weapons grows, so do O&S costs. Analysis of the effects on the capital stock of potential cuts in DoD inventories of weapons--either by retirements of older forces or cuts in procurement of new weapons--suggests that far-reaching changes would be necessary to prevent growth in the value of the capital stock.

One important factor affecting the dollar value of major weapons, of course, is the value of new weapons that are procured. The Administration's February 1988 procurement plan--which is the basis for the CSM estimates presented in Chapter II--reflects an average annual real growth in procurement funding of 3 percent. That plan results in a capital stock of major weapons that increases in value from $682 billion in 1989 to $761 billion in 1993 (see Table 6). Table 6 also shows the effect on that capital stock of assuming annual 5 percent cuts in procurement beyond its 1988 level. By 1993, these reductions would leave procurement 23 percent below its 1988 level in real terms. Stated another way, that means a reduction of about $21.7 billion in procurement funding for the 1989-1991 period from levels currently planned. As can be seen in Table 6, such a reduction in procurement reduces the capital stock of major weapons by only $6 billion or 0.8 percent in 1993, a negligible effect. The percentage reduction is so

small because the stock of capital reflects many years of previous investment decisions. Continued real reductions in procurement funding would gradually make substantial reductions in the capital stock. But over the next five years, it will be difficult to halt growth in the capital stock by changes in procurement funding unless those changes are very large.

Using retirements of older weapons systems to control capital value is equally difficult, largely because the older systems that would be most likely to be retired have relatively small capital values compared with the new items that are currently being delivered. For example, an older F-4 aircraft is valued at about $13 million, whereas a new F-15 aircraft has a value of about $36 million. Thus, about three F-4s would have to be retired to offset the added value of one new F-15 aircraft. In the aggregate, only wholesale retirements of current systems would substantially alter the capital stock and so alter the CSM's projection of needs for increased O&S funding. As Table 7 shows, the retirements needed to reduce capital value in 1989 to 1988 levels might include all of the following: all the ships associated with two carrier battle groups, two Navy air wings, roughly three Air Force air wings, and the equipment associated with two Army divisions.

TABLE 6. CAPITAL STOCK VALUES UNDER ALTERNATIVE PROCUREMENT ASSUMPTIONS (In fiscal years, in billions of 1988 dollars)

	1988	1989	1990	1991	1992	1993
Administration's February 1988 Plan	656	682	691	704	729	761
Annual 5 Percent Reductions from 1988 Funding[a]	656	682	691	704	727	755

SOURCE: Congressional Budget Office estimates.

a. Assumes a two-year lag and that about 30 percent of procurement funding is reflected in capital value. Although there are minor reductions in 1990 and 1991, these are too small to be reflected in this table, as a result of rounding.

In sum, to the degree that O&S costs are determined by the capital stock of major weapons, it will be difficult to hold down growth in these costs over the next five years. This conclusion holds regardless of whether the capital stock reductions take the form of cuts in new procurement or of retirements of existing systems.

MANDATING EFFICIENCIES

If the Congress could successfully mandate more efficient use of O&S funds, then costs could be held down without jeopardizing military readiness. This study makes no attempt to identify specific efficiencies. But clearly, some Members of Congress feel that efficiencies in O&S funding can be achieved without harmful effects. It is also clear that others believe that substantial reductions in O&S funding

TABLE 7. RETIREMENTS NEEDED TO HOLD CAPITAL VALUE TO ZERO REAL GROWTH FROM FISCAL YEAR 1988 TO 1989

Service	Equipment	Units	Capital Value Decrease (Billions of dollars)
Navy	Ships	20	10.9
	Aircraft[a]	172	4.1
Army	Division Sets of Miscellaneous Equipment	2	2.0
Air Force	Aircraft		
	Strategic[b]	90	6.3
	Conventional[c]	216	2.6
Total			25.9

SOURCE: Congressional Budget Office estimates.

a. A-6E aircraft used as a proxy.

b. B-52 bombers assumed retired.

c. Cost reflects a combination of A-7 and F-4 aircraft.

could harm military readiness. Attempts to achieve substantial reductions in O&S costs through efficiencies, therefore, are likely to spark controversy.

The Defense Subcommittees of both the Senate and House Committees on Appropriations have repeatedly suggested detailed ways that DoD might use its operation and maintenance funds more efficiently and so cut its expenditures without harming readiness. Table 8 lists a few examples of possible efficiencies that are suggested in the committees' reports.[1]

Others in the Congress, however, have opposed large cuts in O&S funds, expressing concern about whether military readiness is adequately funded. In a recent report, the Senate Committee on Armed Services explained that it sought to avoid severe cuts in the operation and maintenance accounts, presumably because of fears that such cuts could harm readiness.[2] In addition, the House Committee on Armed Services expressed its concern that "despite the best efforts of the committee to protect the operation and maintenance and stock fund requests, the authorized level of funding does not meet all readiness and quality of life requirements."[3]

The opposing perspectives that the Armed Services and Appropriations committees have expressed in the past exemplify the extent of Congressional disagreement about the nature of possible efficiencies. The Congress may, therefore, find it difficult to identify areas for cutting O&S funding without raising concerns about risks to military readiness. This difficulty can only be compounded by the lack of comprehensive, accepted measures of readiness.

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1. Some analysts might express concern about whether many of these examples are efficiencies. For example, instructing DoD to absorb inflation might cause it to become more efficient; but it might also harm readiness.

2. Senate Committee on Armed Services, *Report on the National Defense Authorization Act for Fiscal Years 1988 and 1989* (May 1987), p. 129.

3. House Committee on Armed Services, *Report on the National Defense Authorization Act for Fiscal Years 1988 and 1989* (April 1987), pp. 158 and 159.

TABLE 8. EXAMPLES OF EFFICIENCY RECOMMENDATIONS MADE BY APPROPRIATIONS COMMITTEES

Senate	House
Fiscal Year 1979	
Absorb inflation to force increased efficiency	Consolidate facilities
Reduce excess Army flying hours	Improve management of DoD supply system
Reduce flying hours used for administrative support airlift	Reduce Army flying hours
Reduce uneconomic leasing of equipment	Improve efficiencies in supplies and equipment purchases
	Reduce uneconomic leasing of equipment
Fiscal Year 1980	
Increase use of military organic transportation assets	Consolidate facilities
Increase efficiency management of FMS storage	Increase use of military hospitals
Absorb inflation to force increased efficiency	Increase efficiency in DoD repair procedures
Increase efficiency in use of government facilities	
Increase use of military hospitals to decrease CHAMPUS usage	
Fiscal Year 1988	
Reduce overhead funding	Reduce uneconomic leasing of equipment
Reduce special use of military aircraft	Consolidate facilities
Increase competition for depot maintenance activities	Reduce overhead positions
	Reduce special use of military aircraft

SOURCE: Reports by Defense Subcommittees of Senate and House Committees on Appropriations on budget requests for various years.

NOTE: FMS = Foreign Military Sales; DoD = Department of Defense; CHAMPUS = Civilian Health and Medical Program of the Uniformed Services.

O&S FUNDING AND MILITARY READINESS

Funding for O&S could easily be reduced in the normal course of adjusting the defense budget to match available budget authority. But if such reductions were made without clearly identified efficiencies and without compensating reductions in the number of military forces, the Congress would accept some risk of the consequences of reduced military readiness.

The Importance of O&S in Maintaining Readiness

Few deny that it is important for U.S. military forces to maintain high readiness, defined as the ability of military forces to fight well early in a war. It is commonly assumed that Warsaw Pact forces will be the aggressors in any future war and that warning time before an attack may be limited. Once the war has begun, NATO forces will need to hold their enemy to modest gains early in the conflict in order to avoid quick defeat and buy time to mobilize military reserves.

O&S funds are undoubtedly related in some way to the ability to fight well early in a war. They pay for training, a key element in maintaining soldiers who are ready to fight. O&S funds also pay for maintenance activities, which keep equipment ready to be used in war on short notice.

Expert assessments appear to corroborate some relationship between O&S funding and readiness. Between 1980 and 1985, O&S funds increased by about 22 percent in real terms. Following the increases, key military and civilian leaders concluded that readiness had increased. For example, in 1986 testimony, Admiral William J. Crowe, Chairman of the Joint Chiefs of Staff, quoted and concurred with his predecessor, General John W. Vessey, saying that "our forces are more ready than at any time in the recent past." More recently, growth in O&S funds has varied, rising in 1987 but decreasing in 1986 and 1988. Decreases in funding may have led to the concerns expressed by senior political and military officials in all of the services that military readiness is beginning to decline. These concerns are reflected in the titles of recent articles in the press, such as "Air Force

is Facing a Critical Gap in Combat Readiness" and "Budget Ax Called Threat to Army Readiness." [4]

If expert opinion agrees that increases in O&S funding have led in the past to improvements in readiness, harm to military readiness could eventually result from substantial reductions in O&S funds unless they are accompanied by offsetting reductions in the forces to be supported. To the extent this is true, it suggests that reductions in O&S funding would be risky.

Despite these expert views, however, clear connections between O&S funding and military readiness--especially in quantitative form--are difficult or impossible to establish. The lack of connections reflects partly the difficulty of defining military readiness in a way that captures its many aspects, and partly the diverse nature of O&S funds, which makes them hard to relate to measures of readiness.[5]

Relating O&S Funding to Readiness

A better understanding is needed of the relationship between O&S funds, which make up more than half of the DoD budget, and the military readiness that those funds seek to sustain. DoD has attempted for many years to develop measures of military readiness. The complexity of what is being measured, however, suggests the difficulty of this task. Readiness is typically broken down into two components: factors related to personnel and those related to materiel. These components often are further broken down into the categories shown in Table 9.

These measures are surely related to readiness. Intelligent, well-trained soldiers and equipment that is available and works are obviously the ingredients of military capability. But it is very hard to know how much a smarter, better-trained soldier adds to readiness, or

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4. John H. Cushman, *The New York Times*, April 6, 1988 and David Tarrant, *European Stars and Stripes*, April 20, 1988. See also Peter Grier, *Christian Science Monitor*, April 11, 1988; Stephen Alexis Cain and James Kitfield, "Defense Budget: Assault on Readiness," *Military Forum*, vol. 4, no. 8 (May 1988), pp. 22-32; and Brendan M. Greeley, Jr., "Navy Reduces Readiness to Finance 600-Ship Fleet," *Aviation Week & Space Technology* (March 7, 1988), p. 16.

5. The conceptual relationship between readiness and expenditures on military personnel, operation and maintenance, and capital stock is discussed in Appendix A.

how much readiness is increased if a larger fraction of aircraft works well. Thus, it is difficult to measure readiness with any precision.

Even once measures of readiness are accepted, it is difficult to relate O&S spending to them because there are so many types of operating activities. Operation and maintenance accounts, which make up about half of total O&S funds, are among the most diverse accounts in the DoD budget. Under the general umbrella of operation and maintenance activities, the accounts fund items as varied as compliance with environmental laws, recruiting and advertising, military

TABLE 9. SELECTED COMPONENTS OF READINESS

Category	Measure
Personnel	
Quality of the recruit	Average category on intelligence tests Years of school
Experience level of the force	Size of the career force[a] Reenlistment rates
Quality of training	Initial[b] Days of basic training
	Follow-on Training days, flying hours, steaming days, number of exercises
Materiel	
Is the equipment available?	Equipment on hand
Does the equipment work?	Mission capable rates
How rapidly is it fixed if broken?	Depot maintenance backlogs

SOURCE: Congressional Budget Office from Department of Defense testimony.

a. The career force is the number of military personnel with more than four years of active service.

b. In general, the Department of Defense uses measures of follow-on training in its readiness discussions, though initial training must influence the caliber of the force as well.

health care, fuel for DoD vehicles, spare parts for DoD equipment, a wide variety of equipment and real property maintenance contracts, and training and exercises.

In practice, the task of isolating readiness-related items has proved to be quite difficult and subject to considerable disagreement. As an example, one could argue that activities to maintain real property (fixing such things as roofs) have less to do with fighting capabilities than do, say, fuel supplies. Yet, testimony by William H. Taft, Deputy Secretary of Defense, quotes the former NATO Commander, General Bernard Rodgers, on the subject of the importance of facilities: "Combat capabilities of our forward-deployed forces are directly related to the quality of the facilities in which those forces work and live."[6] This comment indicates that at least some senior military officials perceive the maintenance of real property to be closely related to readiness.

Nor are the problems of relating O&S funding to readiness limited to the activities associated with the operation and maintenance accounts. It is also difficult to isolate funds that influence the size of the military's career force, usually defined as the number of military personnel with more than four years of active duty. The size of the career force is a measure of the experience level of the force, which is clearly related to readiness. Reenlistment rates will eventually determine the size of this force, though other factors such as changes in minimum requirements for reenlistment and the number of new recruits are also important. Among the categories of O&S funding that determine reenlistment, most, if not all, of the items included in the military personnel accounts affect the financial rewards associated with military service, and thus influence service members' decisions to stay in or leave the armed services.[7] Pay is frequently used to predict reenlistment, but the operation and maintenance accounts also fund benefits that, while less tangible, may also influ-

6. Statement by the Honorable William H. Taft IV, Deputy Secretary of Defense, before the Subcommittee on Readiness, Sustainability, and Support of the Senate Committee on Armed Services, March 25, 1987.

7. Other factors--for example, the state of the economy--will also influence reenlistment rates, but they are outside the control of the Department of Defense.

ence reenlistment. Medical benefits for military dependents left stateside might be very important to the sailor at sea, for example.[8]

The problems of relating O&S funding to readiness are well illustrated by comparing recent trends in O&S funds with measures that DoD commonly uses to describe the readiness of its forces. Many of these measures have improved over the past six years, though a few of them have shown a downward trend. These indicators do not, however, vary rapidly in response to changes in O&S funding. For example, few of the measures listed in Table 9 reflected the reduction in O&S funding that occurred in 1986. It is therefore difficult to make the case that declines in O&S funding will result in immediate degradation of these readiness indicators, though over a longer period they may be sensitive to funding changes.

Indicators of Personnel Readiness. The most clear-cut improvements in readiness over the past few years have come in military personnel, and these improvements have been accompanied in general by growth in military pay. As Table 10 shows, from 1980 to 1986, average spending on military personnel per active duty member increased about 10 percent more than the consumer price index, and also rose 10 percent more than average hourly earnings in the private sector. For the most part, these increases reflect the large military pay raises of October 1980 and October 1981; from 1982 through 1986, both pay raises and real per capita spending rose less rapidly than the consumer price index.

This erratic pattern of pay is only partially repeated in measures of personnel readiness. Commonly used measures of personnel quality improved markedly from 1980 to 1986 (see Table 11). For example, the percentage of enlisted recruits who are high school graduates increased from 65 percent in 1980 to 91 percent in 1986. The experience level of military personnel--as measured by the percentage of enlisted personnel with over four years of military service--also improved, increasing from 42 percent to 49 percent.[9] While the biggest improve-

8. For a discussion of military medical benefits and their effect on readiness, see Congressional Budget Office, *Reforming the Military Health Care System* (January 1988).

9. That this rise would be less marked than the other measures is not surprising because of the inevitable time lag.

ments in these measures generally occurred between 1980 and 1982, neither recruit quality nor the reenlistment rate has declined noticeably since then.

DoD measures of the amount of training received by its personnel also showed occasional increases, but no definitive pattern can be observed (see Table 11). While training hours flown by pilots in the Air Force and Navy increased over the period from 1980 to 1986, Navy ship steaming days (excluding those while on overseas deployments) and Army tank mileage declined. Moreover, while three of the training measures cited in Table 11 declined when funding was cut sharply in 1986, one (Navy flying hours) remained constant and another (Army flying hours) actually increased.

TABLE 10. PER CAPITA COMPENSATION FOR ACTIVE FORCES

	1980	1981	1982	1983	1984	1985	1986	Percent Change, 1980-1986
Current Dollars								
Per Capita Compensation	14,000	16,300	18,600	19,300	20,200	20,900	20,400	46
Percent Change Over Preceding Year	n.a.	16	14	4	5	3	-2	n.a.
Adjusted for the Consumer Price Index								
Per Capita Compensation	18,600	19,700	21,100	21,300	21,300	21,300	20,400	10
Percent Change Over Preceding Year	n.a.	6	7	1	1	0	-4	n.a.
Adjusted for Increases in Average Hourly Earnings								
Per Capita Compensation	18,600	19,900	21,200	21,100	21,300	21,400	20,400	10
Percent Change Over Preceding Year	n.a.	7	7	-1	2	0	-5	n.a.

SOURCE: Congressional Budget Office estimates from Department of Defense data.

NOTE: n.a. = not applicable.

These measures are only one indicator of how well DoD trains its people. The Army, for example, now attempts to simulate combat conditions for battalions at its National Training Center. This more realistic--and presumably more effective but more costly--form of training might offset declines in how far tanks are driven each year.

TABLE 11. PERSONNEL READINESS IN SELECTED FISCAL YEARS

	1980	1985	1986
Quality of Personnel			
Quality of Recruits			
Percentage of recruits with no previous service who are high school graduates	65	n.a.	91
Percentage of recruits scoring in top three categories (I-III on entrance exam)	73	n.a.	91
Experience Level of Enlisted Career Force			
Percentage of active component with over four years of service	42	n.a.	49
Training of Personnel			
Pilot Flying Hours (Per pilot, per month)			
Army tactical	n.a.	13.1	13.6
Navy and Marine Corps (TacAir and ASW)	24.2	25.0	25.0
Air Force	15.6	19.0	18.8
Ship Steaming Days[a] (Per ship, per quarter)	28.9	27.4	26.9
Army Tank Mileage (Miles per year)	1,000	850	830

SOURCE: Testimony by William H. Taft IV, Deputy Secretary of Defense, before the Senate Committee on Armed Services, Subcommittee on Readiness, Sustainability, and Support, March 25, 1987, pp. 670 and 672.

NOTE: n.a. = not available; TacAir = tactical (fighter and attack) aircraft; ASW = anti-submarine warfare.

a. For ships that are not deployed.

Indicators of Materiel Readiness. Many measures of equipment readiness also display upward trends during 1980 to 1986, though the trends are often less marked than those exhibited by measures of personnel readiness (see Table 12). For example, mission capable rates for all types of aircraft listed in Table 12 are higher in 1986 than they were in 1980. (A weapons system is considered mission capable if it can perform at least one of its primary missions.) Improvements in mission capable rates range from 14 percent for Army aircraft to about 30 percent for Navy fighter and attack aircraft. Mission capable rates for the Army's ground equipment, however, have moved up only slightly, and mission capable rates in the Marine Corps have remained stable or fallen slightly, perhaps reflecting the already high level of these rates in 1980.[10]

The patterns for mission capable rates from 1985 to 1986 do not appear to reflect funding cuts for 1986. Of the mission capable rates for 13 kinds of systems measured, seven remained constant or increased between 1985 and 1986 while only six declined. Although this finding casts doubt on the sensitivity of the measures to funding cuts in the short run, it does not disprove the possibility of a connection between the two. For example, there may be lags between reductions in funding and the time those reductions are reflected in lower inventory levels of spare parts in the field, a factor that would influence mission capable rates.

Depot maintenance backlogs--the dollar value of needed repairs that are delayed by funding shortages--declined between 1980 and 1986, and this measure has varied more closely with funding. The backlog in 1986 was about half that of 1980. This measure appears to be the only one showing much sensitivity to the funding cuts in 1986; it nearly doubled between 1985 and 1986.[11]

10. Army and Marine Corps data reflect fully mission capable rates because their weapons systems have only one primary mission.

11. Many analysts disagree with using depot maintenance backlogs as a readiness measure, since they argue that funds allocated to depot maintenance are frequently used for other projects by the services. For example, over the past three years, for which actual data are available, less money was expended for depot maintenance than was appropriated. In 1984, the difference was $0.7 billion, rising to $0.8 billion in 1985, and increasing dramatically to $1.8 billion in 1986.

TABLE 12. MATERIEL READINESS IN SELECTED FISCAL YEARS

	1980	1985	1986
Mission Capable Rates (Percents)			
Army (FMC)			
Aircraft	66	74	75
Fire Support Artillery	88	93	92
Fire Support Missile Systems	91	96	96
Tanks	86	87	85
Combat and Combat Support Vehicles	88	89	89
Navy (MC)[a]			
Total Aircraft	59	71	74
Fighter and Attack Aircraft	53	66	70
Air Force (MC)			
Total Aircraft	66	75	78
Fighter and Attack Aircraft	62	76	77
Marine Corps (FMC)			
Artillery	88	88	84
Missile Systems	94	90	88
Tanks	86	87	86
Combat Vehicles	84	89	81
Depot Maintenance Backlogs (Millions of 1988 dollars)			
Unperformed Maintenance	790	190	330

SOURCE: Testimony by William H. Taft IV, Deputy Secretary of Defense, before the Senate Com-mittee on Armed Services, Subcommittee on Readiness, Sustainability and Support, March 25, 1987, p. 676, and Congressional Budget Office estimates based on Department of Defense data.

NOTE: Mission capable rates measure the percentage of available equipment that is able to perform the missions it is intended for. Fully mission capable (FMC) means it can perform all primary missions. Mission capable (MC) means it can perform at least one primary mission. FMC rates are presented for Army and Marine Corps systems, because they have one primary mission.

a. Includes U.S. Marine Corps aircraft.

Aggregate Measures of Readiness. In addition to the detailed measures just discussed, DoD maintains aggregate readiness measures, the so-called C-ratings, that are reported by unit commanders and tabulated in the DoD's *Unit Status and Identity Report.* According to a DoD report on measures of readiness, C-ratings measure "unit personnel resources (the number and skill mix of assigned personnel) relative to wartime requirements, . . . [the] amount and condition of equipment relative to wartime requirements, and . . . [the] level of unit training relative to Service standards."[12]

Most of the C-ratings are classified and so are not publicly available. But, at least in one case that has been publicly reported, the C-ratings have apparently not responded markedly to changes in O&S funding. According to testimony by the Director of Plans and Policy, U.S. European Command, these measures have remained constant for the European Command over the past five years despite substantial increases in O&S funding.[13]

The constancy of these particular C-ratings in the face of higher O&S spending may indicate as much about problems with the C-ratings as it does about the difficulty of relating O&S funds to readiness. Indeed, the Director of the European Command argued that readiness had improved dramatically and that the constancy of the C-ratings stemmed from definitional changes over time, largely related to the fielding of new weapons systems. (For example, a unit that was fully ready with an old weapons system would be judged less ready during transition to a more modern one.) The C-ratings system has also been criticized on other grounds. Some have claimed that it is too dependent on the subjective evaluations of military commanders, and cannot be used to track changes over time because of the rotation of military personnel. Similarly, comparisons among units might also be colored by subjective judgments.

The C-ratings do not seem to offer a good means for this study to relate readiness to O&S funding. Indeed, the link between aggregate

12. Department of Defense, *Report to Congress on the Status of Efforts to Measure Readiness* (February 1988), p. 3.

13. Statement by Major General Thomas L. Craig, Director, Plans and Policy, U.S. European Command before the Readiness, Sustainability, and Support Subcommittee of the Senate Committee on Armed Services, March 4, 1987, p. 365.

measures of readiness like the C-ratings and O&S funding may be more tenuous than the link between O&S funding and some of the more detailed readiness measures discussed above.[14]

WEIGHING THE EFFECTS OF LIMITING O&S FUNDING

It is reasonable to assume that a relationship exists between military readiness and at least some types of O&S funding: more money for peacetime operations would seemingly improve the services' abilities to fight well early in a war. In the case of many specific operational programs--training, equipment maintenance, and fuel availability, to name a few--the logical case for formulating a connection is compelling. In other cases--such as medical care, recruiting, or communications--the connection seems less direct. And in still others--for example, base operations, real property maintenance, and administration--a connection is even harder to demonstrate, though some military experts believe it exists.

Yet, considerable uncertainty remains about the connections, especially the quantitative ones, between O&S funding and military readiness. Changes in readiness indicators appear to lag behind increases or decreases in O&S spending, suggesting that the services may have some ability to reallocate funds to critical functions. Even in the long run, the effect of funding on measures of readiness has not been clearly established.

The absence of clear connections does not mean that reductions in O&S funding without corresponding force reductions are devoid of risk. It does mean, however, that analysis cannot clearly establish the degree of risk involved in such reductions. Without a quantitative link between O&S funding and the degree of military readiness, the Congress has no easy alternative to weighing expert opinion and its own priorities for specific O&S activities and the overall level of defense funding.

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14. For DoD perspectives on the C-rating system, see Department of Defense, *Report to Congress on the Status of DoD Readiness Measures* (February 1988), pp. 3 and 4. Perhaps because of the insensitivity of C-ratings to funding changes, DoD has argued that the reporting system should be used only as an internal management tool, rather than as a measure of probable combat outcomes. In fact, DoD changed the meaning of "C" in C-rating from "combat rating" to "category level" in an attempt to deemphasize this connection, though the underlying formulas apparently remain unchanged.

APPENDIXES

APPENDIX A

MODELS USED IN THIS STUDY

This appendix discusses the two major models used in this study in more detail, providing technical information about their assumptions and methodologies.

The Defense Resources Model

The Congressional Budget Office (CBO) has used the Defense Resources Model (DRM), which was developed for CBO in the 1970s, in support of Congressional budget deliberations to estimate the operation and support (O&S) costs implied by changes in military forces. The model has been used to estimate the costs of developing a 600-ship Navy, stationing Army divisions in Europe, increasing the Air Force to 40 tactical air wings, and many other options. The DRM was built in the spirit of CBO's baseline budget projections, where the policies implicit in the base year's budget are assumed to remain constant into the future.[1] Consequently, it is a projection model more than a predictive model.

The DRM is primarily a projection model because its cost relationships center on the many personnel, facilities, and weapons policies affecting O&S in one budget year. Cost factors are computed on the assumption that the cost of operating a unit of force, for example, an Army division, is best measured by what the Army now spends on that unit. In this sense, costs could go up if the Congress and the Army choose to spend more and costs could go down if the opposite happens.

The DRM is not a predictive model: it does not forecast how the Congress and the Department of Defense (DoD) will change policies in the future. For example, it does not predict whether operating tempos--the number of flying hours, steaming days, or tank miles--will in-

1. For a discussion of CBO's baseline concepts, see Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 1989-1993* (February 1988), pp. 115-122.

crease or decrease, nor does it predict whether or not DoD will be able to achieve efficiencies in its operations. The DRM measures the budgetary impact of changes only in the number of forces, and consequently, the incremental impact on the budget of any change could be applied to any budget base with reasonable accuracy.

The cost projection has two parts--the computation of direct and indirect costs--and hinges on the resource allocations in DoD's five-year defense plan.

The DRM and the Five-Year Defense Plan. Understanding the DRM data base helps in understanding the model. The data base is a "roll-up" of program elements--the lowest level of aggregation in the budget structure of the five-year defense plan. Operation and investment costs are allocated to each program element when the budget is prepared. For example, separate program elements exist for major forces like B-52 bombers or frigates, and these program elements display the funds for direct operations and investment budgeted for these forces.

The DRM uses data at the level of program elements in the five-year defense plan to compute the direct costs for most major forces, but for other computations the DRM either disaggregates or aggregates these data. For example, aircraft carriers will have different operating costs depending on whether they are powered by a nuclear reactor or by conventional means. The program element contains all resources for the two types of carriers, so the data are disaggregated to give two DRM program elements. Similar disaggregations occur for submarines, cruisers, and Army divisions (for divisions, the relevant dimensions are type of division--for example, infantry or armored--and location--for example, stateside or overseas).

The program elements of the five-year defense plan are usually aggregated when they represent similar functions and can be combined to make the data base unclassified and more manageable. For example, about 465 program elements pertaining to research and development are combined to yield about 20 aggregated elements in the DRM. About 790 program elements that relate to central support functions are aggregated to yield about 60 aggregated elements in the DRM. Overall, the five-year defense plan has about 2,500 program

elements and the DRM has about 340 aggregated elements that are grouped into the categories shown in Table A-1.

Direct Costs. Strategic forces and tactical and mobility forces are the two categories with major forces, and hence the only two categories for which the DRM computes direct costs of force changes. Major forces include Army divisions; Army separate brigades and regiments; land-based intercontinental ballistic missiles; bomber, fighter, attack, and airlift aircraft; and ships. Direct costs include such items as fuel and spare parts, and pay for the military personnel assigned to the force unit.

The number of major forces is related to direct costs that the DRM assumes are allocated to a program element of the five-year defense plan, and consequently to an aggregated element. Roughly 35 percent of DoD's total O&S budget is allocated to this cost category. The DRM divides the number of forces--for example, frigates--allocated to the relevant aggregated elements into the funds budgeted for operations, thereby computing a cost factor for the direct annual costs of the force element. The DRM assumes that these cost factors per unit are constant in real terms throughout the period for which costs are projected; that is, the DRM does not assume that operating tempos and policies change, or that resources are used any more or less efficiently.

When calculating the cost of a change in forces for the first year, the DRM assumes the change occurs during the middle of the year and so raises or reduces costs by half the annual amount. For example, the DRM would project that the savings from retiring one wing of 72 Air Force F-4 aircraft would be about $85 million of direct costs in the year the change is made and about $170 million annually thereafter.

Indirect Costs. The DRM also computes the indirect costs of force changes. Indirect costs are sometimes called the support "tail" and include such functions as training, medical care, logistics, and base operations. The computations assume that O&S funds in the support tail have a linear relationship to O&S funds in the force programs. Similarly, they assume that O&S funds in the broader categories of support--for example, medical and personnel support--have a linear relationship to O&S funds in the force programs and narrower categories of support--for example, training.

to be related to capital stock. Funds for medical care or base operations fall in this category.

Notwithstanding these intuitive conclusions, empirical analysis shows that total O&S spending was related to the value of DoD's capital stock for the period since 1975. Accordingly, this study uses the Capital Stock Model (CSM) as one of its methods for estimating O&S costs.

Estimating Capital Stock. Capital stock in DoD could be measured in many different ways.[2] In practice, a number of different measures of capital stock were considered in this analysis, each implying a different view of what determines O&S costs. The measures also differed in terms of how comprehensively they accounted for the services' capital assets.

One estimate of the dollar value of DoD's capital stock included only *major weapons*--inventories of items such as ships, planes and tanks that DoD viewed as sufficiently important to count individually and for which historical inventory data exist. Another--*total weapons*--added to the stock of major weapons an estimate of the dollar value of diverse DoD items for which historical inventory data do not exist. Examples of such items include tactical air-to-air and air-to-ground missiles. Estimates of the value of these diverse items in the total weapons estimate were made using a perpetual inventory estimating technique. In the perpetual inventory method, funds in an account, for example, weapons procurement that buys tactical missiles, are assumed to behave as inventories. The method assumes a standard procurement lag, attrition rate, and retirement age. Since by definition these accounts buy a variety of systems, this assumption of standardization calls the accuracy of the estimates into question. This difficulty is particularly striking with accounts like "other procurement" that buy items as diverse as trucks and satellites.[3]

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2. Annual estimates of the Department of Defense's capital value are also constructed by the Bureau of Economic Analysis of the Department of Commerce.

3. For an example of a perpetual inventory capital stock series, see Charles R. Roll, Jr., "Potential for Capital-Labor Substitution," (paper given to the Conference on the Economics of National Security sponsored by the United States Air Force Academy and the RAND Corporation, August 15-18, 1979).

Yet a third measure--*total DoD assets*--added to the total weapons capital stock the estimated value of DoD's real property (buildings and facilities). This third level of aggregation, total DoD assets, compounds the problems associated with perpetual inventory estimation by adding the estimate for total weapons to values for real property that may not have been adequately corrected for inflation and for which assumptions about the kinds of data to include may not have been the same in all the services. Major weapons represent about 50 percent of total DoD capital stock and total weapons about 70 percent.

All three of these capital stock values have been proportional to O&S costs during the years since 1975.[4] Figure A-1 shows the historical ratios (expressed as a percentage) of O&S funding to the various levels of capital values estimated. (All estimates are in constant 1988 dollars.) As the figure shows, the ratios have been fairly constant for the past 12 years, varying by a maximum of four percentage points.

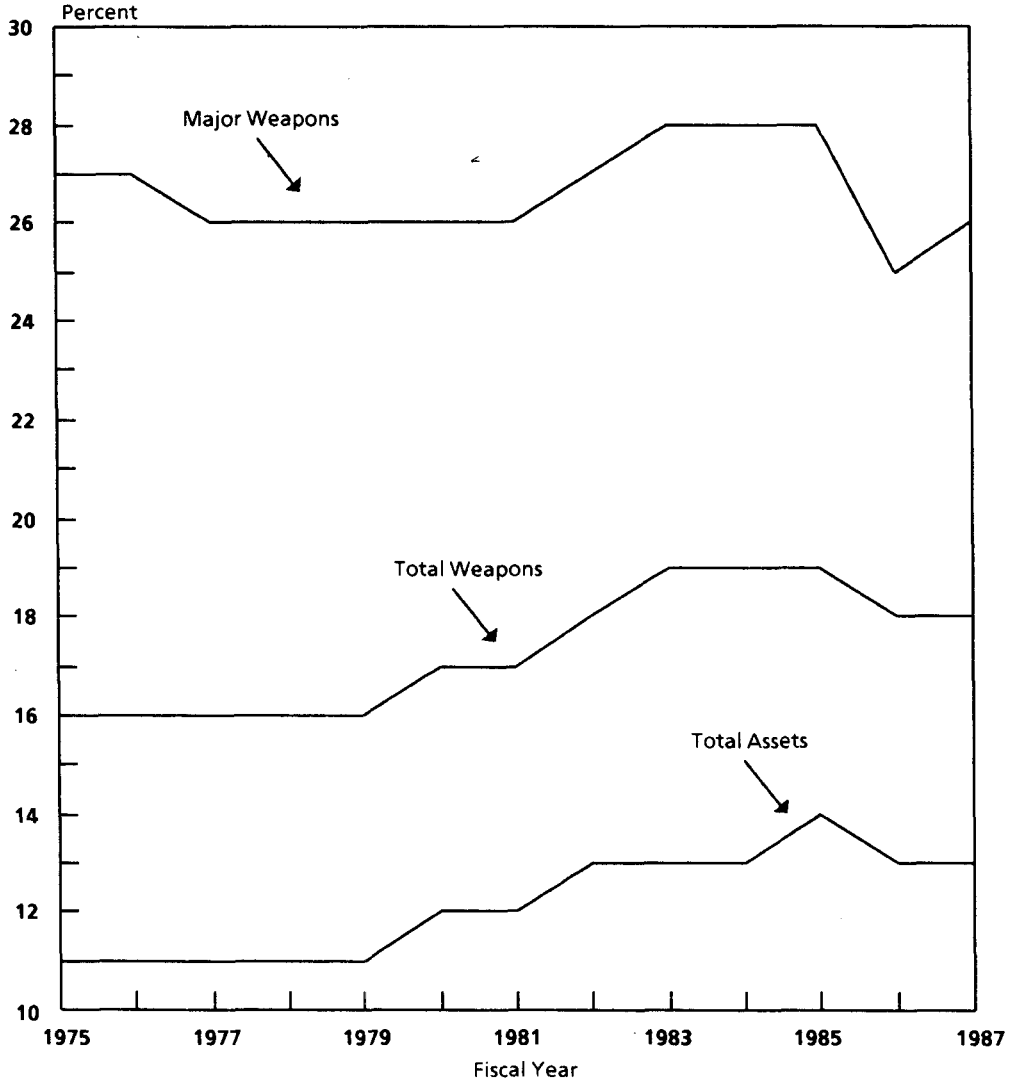
The major weapons capital value was chosen in this analysis because it offers several advantages over the values for total weapons or total DoD assets. The first advantage is ease of calculation, an important consideration in a model that will probably be run repeatedly in a variety of budgetary conditions. The second advantage is confidence that the data used to estimate major weapons capital stock are more accurate than the data used in the perpetual inventory technique (for total weapons) and the data on the value of DoD real property (for total DoD assets). Finally, it is plausible that major weapons purchases, with their pervasive influence on the rest of the defense budget, might have the greatest and most direct effect on O&S costs.

The capital stock of major weapons was constructed using historical counts of ships, planes, tanks, and helicopters that were in the DoD inventory. To convert the number of items to a dollar value, a unit cost for each item of equipment (expressed in constant 1988 dollars) was multiplied by the inventory of that kind of equipment. Unit procurement costs were used for all ships and major weapons systems in

4. The period from 1975 to 1987 represents existing data. Before 1975, some service inventory data were not available. There is little reason to attempt to construct a much earlier time series, since the intent of estimating peacetime operating costs might preclude using data from the Vietnam War era. In wartime, the ratio of operating costs to capital stock would presumably be much higher than in peacetime.

the Army; these unit costs equal total procurement costs divided by the number of items procured. Historical cost data for fixed-wing aircraft were available only at the "flyaway" level, which excludes some procurement costs (such as special ground support equipment) and is

Figure A-1.
O&S Costs as a Percentage of Three Capital Value Measures

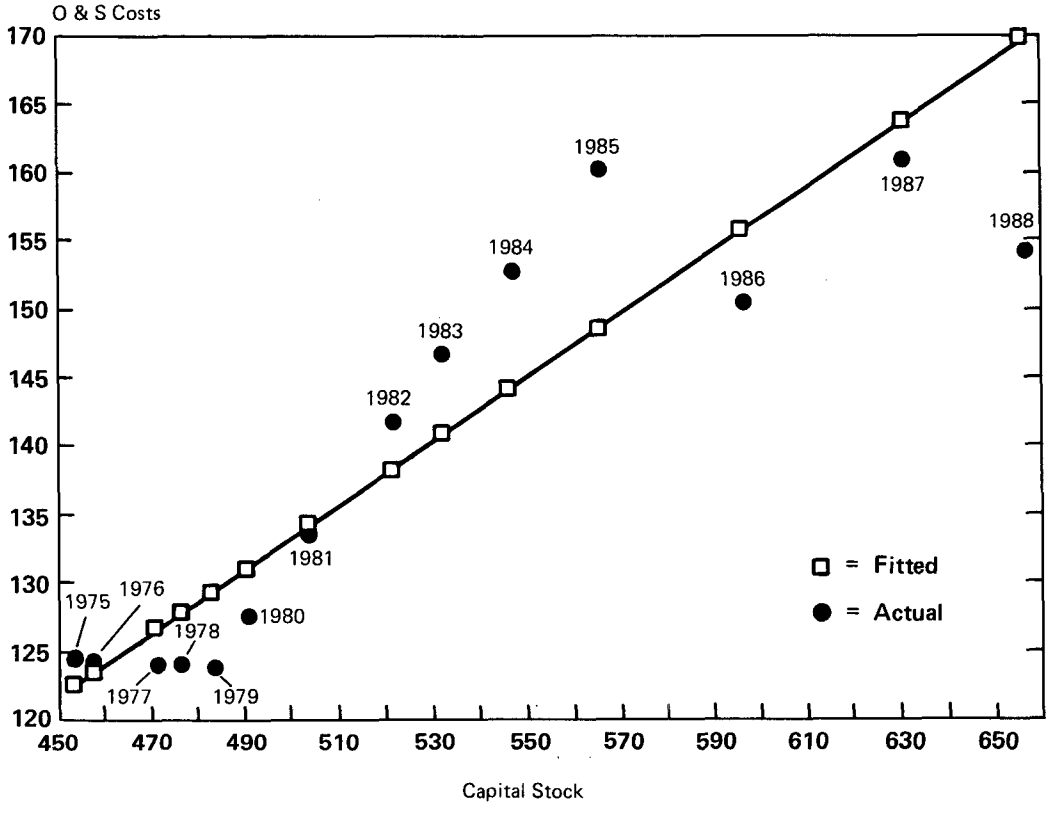


SOURCE: Congressional Budget Office estimates.

frequently assumed to be two-thirds of total procurement funding. The analysis used this factor of two-thirds to estimate procurement unit costs from the flyaway cost. (Weapons values were estimated using only flyaway cost estimates for aircraft and results are comparable to the ones shown here.)

Relating O&S to Capital Stock. Two methods of estimating the relationship of O&S to capital stock were used: a simple ratio calculation and a statistical regression analysis. Given the constancy of the ratio over time, the simple average of the annual ratios could be used to project O&S funding. The ratios for the period from 1975 to 1988

Figure A-2.
O & S Costs and Capital Stock: Fitted Values Compared with Actuals, Fiscal Years 1975-1988 (In billions of 1988 dollars)



SOURCE: Congressional Budget Office estimates based on Department of Defense data.

vary by only five percentage points, with the lowest ratio in 1988 and the highest in 1985. The average ratio over the period from 1975 to 1988, 26 percent, was used to project real growth of 5.5 percent per year. Alternatively, the 1988 ratio might be considered a more realistic estimate for future spending. Hence, that value was used for a second projection, that O&S funding would grow at a rate of 3 percent per year.

The statistical regression equation can also be used to project O&S costs. The equation incorporated data for the period from 1975 to 1987. Data from 1988 were omitted from the equation because, as Figure A-2 on the preceding page shows, they differ dramatically from other data points.[5] The baseline estimates in the text use data from the current period to adjust projections downward by the amount the equation overpredicts the 1989 budget request.

The regression equation was statistically significant, with signs that seemed intuitively logical, and explained 86 percent of the variance in O&S spending. The equation for the relationship used in the text is:

O&S = 17,214 + 0.232 (capital stock value)
(0.57) (4.10)
Standard error = 5499
R bar squared = 0.86
Durbin Watson = 1.82

where figures in parentheses are t-statistics. When data for 1988 and for the 1989 proposed budget are included in the equation, the statistical relationship becomes much less clear. The equation is:

O&S = 101,360 + 0.080 (capital stock value)
(1.13) (0.58)
Standard error = 5946
R bar squared = 0.83
Durbin Watson = 2.27

where figures in parentheses are t-statistics.

5. In statistical terminology, the 1988 data point meets the criteria that would cause it to be characterized as an "outlier" and thus to be excluded from the analysis. Economic time-series analysis often excludes data points for particular years, such as World War II or the Great Depression, on the grounds that economic conditions in those years do not provide a basis for extrapolation. While the conceptual reasons for excluding 1988 from the equation are less clear than either of these two examples, the articles discussed earlier provide evidence that the Department of Defense may be concerned about the level of funding for that year.

Figure A-2 is a visual representation of how well the regression equation compares with historical data. The line in Figure A-2 shows the values of O&S costs projected by the equation (the so-called "fitted values"), given the historical values of capital stock in each year. The actual O&S values in these years are shown as points scattered about the line.

The figure reveals a pattern in the differences (the "residuals") between fitted and actual values.[6] For the 1970s, fitted values exceed actual values and thus the residuals are negative, indicating that the model would have projected higher O&S spending than actually occurred during a period when readiness was widely perceived as being at a low ebb. From 1982 through 1985, residuals are positive, indicating that the model would have projected less O&S spending than the actual amount. Perceptions about readiness were generally positive during these years.

Beginning in 1986, residuals once again are negative, and indeed there is a large negative residual for 1988. This relationship could indicate that O&S funding substantially below levels predicted by historical experience might again lead at least to perceptions that readiness levels are declining.

These observations about readiness suggest that the regression equation might be better specified statistically if it were possible to include readiness as an explicit variable. Using the terminology of economics, readiness might be thought of as produced by a combination of fixed inputs (capital stock) and variable inputs (military personnel and others represented by the activities included in the operation and maintenance accounts). Assuming that the efficient amounts of these inputs are used, such a "production function" for readiness can be rewritten as a cost function in which the variable costs of military personnel and operation and maintenance depend on the level of readiness (output) and the amount of capital stock.

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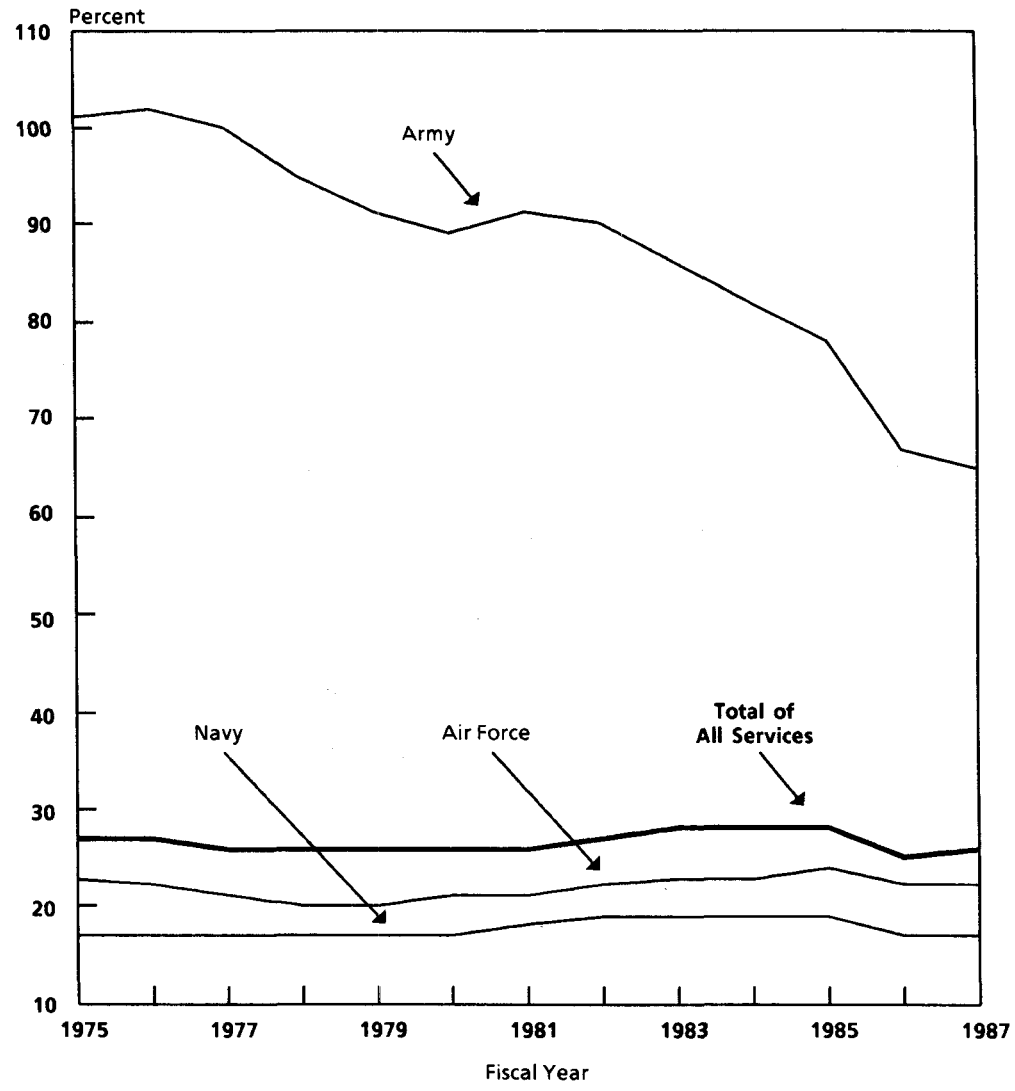
6. This sort of a pattern also indicates a statistical problem related to the data. The problem is called autocorrelation and means that the observations for various periods are statistically related to each other. Methods for measuring autocorrelation--the Durbin-Watson test--and for adjusting the equations to correct for it--the Cochrane-Orcutt procedure--have been employed to adjust all equations for autocorrelation.

Figure A-3.
O&S Costs as a Percentage of
Major Weapons Values in the Services



SOURCE: Congressional Budget Office estimates.

Lacking a measure of readiness, this equation cannot be estimated. Instead, the CSM implicitly holds constant the level of readiness in estimating the relation between the sum of the costs of labor and other variable inputs on the one hand, and the cost of capital on the other. The observed pattern of residuals suggests the importance

of the omitted variable, readiness, but as long as the level of readiness does not change in the future, the estimated equation can be used for purposes of projection.

Other Specifications. An issue in the construction of the model was whether it was appropriate to use the same capital stock measure for all of the services. Figure A-3 on the preceding page shows the ratios of O&S funding (expressed as percentages) in the three services to major weapons values for each service over the past 12 years. For two services--the Air Force and the Navy--the ratios are roughly constant, varying during the 1975-1987 period by only four percentage points for the Air Force and two percentage points for the Navy. For the Army, however, the ratio declines dramatically from a high of 102 percent in 1976 to 65 percent in 1987. This decline reflects rapid increases in the portion of the Army's capital stock in the major weapons category, from 37 percent of total weapons in 1975 to 51 percent by 1987. The increases occurred because the Army added major, expensive new weapons to its inventory, including the M-1 tank, the Bradley Fighting Vehicle, and the Apache helicopter.

Thus, an alternative specification of the model that uses major weapons capital for the Navy and the Air Force and total weapons for the Army was considered. This version of the model, like the others, offered a good statistical relationship. But it yields a much higher estimate of annual real growth in O&S through 1993 than does the version using major weapons capital stock for the Army. One explanation for this high projection is that the Army has achieved economies in the cost of supporting its major weapons, economies that are ignored in this specification.

Two other alternative versions of the CSM--one fixing portions of O&S costs and another estimating operation and maintenance costs based on capital stock and military personnel--were also considered. Because of conceptual problems with the models, they are not discussed here or used in the study to project funding.

APPENDIX B

OTHER OPERATION AND SUPPORT MODELS

Many other models are used to estimate operation and support (O&S) needs. None provides estimates that cover the whole of the Department of Defense (DoD), and therefore these other models are not used in this study. Nonetheless, a brief discussion of five of the models may provide an understanding of alternative approaches to estimating O&S funding needs. This appendix also discusses two new models that are under development and offer the promise of improved estimating capability.

The CORE Model

The Air Force's Cost Oriented Resource Estimating (CORE) model calculates squadron operating costs for aircraft. Input to the model is based on historical expenditure data, some of which are derived from other Air Force models. In some cases (for example, squadron manning levels), data are estimates from the previous budget year. In other cases, such as depot maintenance costs, estimates are derived from historical expenditure data, adjusted statistically for a variety of reasons including the age and cost of the systems.[1]

CORE is sometimes described as a "cost factors" model--that is, a model that estimates the marginal cost factor of adding or deleting a squadron of a particular kind of plane and applies that factor to squadrons of those planes through the estimating period. The model is primarily used for "what if?" programming exercises and to provide independent cost estimates for the evaluation of systems development. Since the model does not estimate the total average costs of Air Force

1. CORE's depot maintenance cost estimates, for example, are the output of the Weapons System Cost Retrieval System, a data base run by the Air Force Logistics Command to collect actual costs of depot maintenance activities.

systems, it cannot be used to estimate total Air Force requirements for O&S funds.[2]

The NARM

The Navy Resource Model (NARM) is similar to the CORE model in that it estimates average marginal operating costs for a variety of Navy systems. It also uses historical expenditure data to project future systems costs. The Navy used the NARM to derive direct and indirect costs for its ships and planes only through 1980, and direct costs through 1982. Since then, the Navy has been developing a data base that may eventually lead to expenditure-based O&S cost estimates for all major Navy weapons systems.

The AFPCH

This *Army Force Planning Cost Handbook* (AFPCH) resembles the other cost factors approaches, except that most of the factors are expressed on a per capita basis rather than per system. The model produces estimates of one-time and recurring factors for direct O&S costs and support costs, all of which are reported in the *Army Force Planning Cost Handbook*. These cost factors vary depending upon the organizational equipment of each unit and its location. As with the other factors models, AFPCH is primarily intended to capture marginal costs associated with a force change.

In 1982, the Army became concerned about the quality of the historical data used by the AFPCH model and adopted a budget-based factors approach. This approach uses the costs associated with a system in the budget to project future costs for the system.

The *U.S. Army OMA & MPA Cost Factors Handbook*--using budgetary data--was last published in 1984. Since then, the Army has been updating these factors when they are required for specific esti-

2. CORE, which only estimates costs for active systems, is being replaced by a model called Systematic Approach to Better Long-range Estimating (SABLE). SABLE estimates O&S costs for Reserve and Guard squadrons as well as active squadrons. It is currently being used by the Air Staff and by some of the Air Force's major commands for budget exercises, though it also estimates only marginal costs.

mates. The Army plans to develop a model for O&S cost estimation to replace the AFPCH.

The Resource Dynamics Model

This model estimates total Navy O&S costs. While the model uses statistical regression techniques--chiefly to estimate maintenance costs--it also uses pro rata and fixed factors where regression relationships were not found. Input to the model includes force structure, system characteristics, asset value, and historical O&S data from the VAMOSC data base (discussed below).[3]

The Navy O&S Cost Model

The Navy O&S Cost Model estimates total Navy O&S costs. For input, the model uses historical cost data, a variety of systems characteristics, and asset values. The model estimates costs based on the best fits in regression equations for historical systems costs. Details of the model are classified.[4]

MODELS UNDER DEVELOPMENT

As the above discussion indicates, there is considerable room for improvement in the data and methods used to estimate O&S costs. For example, none of the models relates O&S costs to measures of readiness. Several efforts are underway in DoD to improve this situation. One, Visibility and Management of O&S Costs (VAMOSC), grows out of a long-term effort by the Office of the Secretary of Defense

3. For a description of the model's methodology, see Rolf Clark, "Navy Resource Dynamics: Planning Future Forces and Budget," in Hans W. Hofmann and Heinz Schelle, ed., *Kosten in der Verteidigungsplanung* (Munich: Verlag für Wehrwissenschaften, 1985). For a discussion of Navy O&S cost relationships, see Rolf Clark, "Operating and Support Costs of the U.S. Navy: Some Analytic Facts," in John C. Honig, ed., *Budgeting for Sustainability* (Baltimore: Operations Research Society of America, 1986).

4. This model was developed for the Office of the Secretary of Defense by the Institute for Defense Analyses. A description of the model is available in Jerome Bracken and others, *Navy Operating and Support Cost Model* (June 1985), IDA Report R-298, prepared for Office of Secretary of Defense, Director, Program Analysis and Evaluation, (Secret).

to build a base of historical expenditure data to support budgetary projections. Another Navy effort, the Resources to Readiness Model, shows some promise in relating expenditure data to one measure of readiness--mission capable rates.

The VAMOSC Data Base

The concept of VAMOSC (Visibility and Management of O&S Costs) has existed since the mid-1970s. It is envisioned as being a collection of expenditure data that would provide system-specific operating costs, using existing data-reporting systems. The CORE and AFPCH models, and the NARM are all examples of data collection efforts that VAMOSC would use as a source of information. Once sufficient historical data had been collected, VAMOSC could be used to estimate future costs.

Perhaps in part because of the requirement not to add to reporting efforts by the services, VAMOSC has to date enjoyed only limited success. Difficulties arise when the services' existing reporting systems collect information as "line items" rather than as data specific to different weapons systems. An example could be a radio that is used on many different kinds of aircraft. The depot that repairs those radios may know how many radios (as line items) are replaced or repaired, but may not know that radios are repaired every week for one type of plane but every two years for another.

Partly for this reason, the VAMOSC data are not consistently useful. The data base for Navy ships, specifically aircraft carriers, is widely viewed as being better than that for Navy aircraft, because the Navy accounts for many operating costs by carrier but not by plane or squadron. There may be hope for improvement in the system in the future, largely because of improvements in computer technology that may eventually enable the services to record the destination of a particular spare part and hence allocate its costs more accurately. The cost of establishing such computerized data bases, however, will be high, and it could be many years before all of the services are able to realize the full potential of VAMOSC.[5]

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5. The Air Force is currently engaged in an effort to use computers for much of VAMOSC's data collection.

The Navy Resources to Readiness Model

This model, also currently in its beginning stages, promises some improvement in relating a variety of expenditure data to readiness ratings.[6] In particular, the model purports to be able to predict the time ships must spend out of operation for maintenance by using overhaul and expenditure data from VAMOSC. If such predictions can be made for ships, they may also be able to be calculated for other DoD weapons systems. Indeed, the contractor working on the ship model has also developed a Navy aircraft model that shows promise.[7]

6. Mathtech, Inc., "Navy Ships Resources-to-Readiness Model" (a briefing prepared for the Department of the Navy, September 30, 1987).

7. Mathtech, Inc., "Relating Logistics Resources and Flying Hours to Aviation Readiness" (a briefing prepared for the Department of the Navy, September 30, 1987).